SECTION G, PART 0

TANDEM CALL, TROUBLE CARD ANALYSIS

Index

		PAGE
G0	TANDEM CALL - TROUBLE CARD ANALYSIS	G0-2
G0-1	FLOWCHART AND TROUBLE ANALYSIS SEQUENCE CHART	G0-2
G0-1.1	USE OF FLOWCHART AND TROUBLE ANALYSIS SEQUENCE CHART	G0-2
G0-2	SEQUENCE CHARTS	G0-3
G0-3	CROSS DETECTION, SEQUENCE FAILURES (SFD-G002)	G0-4
G0-4	TIMING JUNCTIONS	G0-4
G0-4.1	OVERALL TIMER (OAT)	G0-4
G0-4.2	WORK TIMER (WT)	G0-4
G0-4.3	SHORT DELAY TIMER (SDT) AND LONG DELAY TIMER (LDT)	G0-5
G0-4.4	TRANSFER START TIMER (TRS)	G0-5
G0-5	FALSE CROSS-GROUND (FCG) TEST	G0-5
G0-6	LINK RELEASE (LR) WITH OR WITHOUT DCK	G0-5

G0 TANDEM CALL - TROUBLE CARD ANALYSIS

The trouble analysis flowcharts in the A2 section of the SFD direct the reader to one of the oblong boxes† at the left of SFD G002 for tandem outgoing call trouble record cards. The flowchart supplies information and directs the user to the trouble analysis sequence chart which in turn refers to a sequence chart.

G0-1 FLOWCHART AND TROUBLE ANALYSIS SEQUENCE CHART

The flowchart on SFD-G002 is used in the same manner as the trouble analysis flowcharts on SFD-A2. The user, having determined the type of call and stage from SFD-A2, is directed to SFD G002. Then, by observing the trouble record card and making decisions, the craft person is supplied needed information or directed to the trouble analysis sequence chart.

Standard SD sequence charts generally show a sequence of relay operation and release. All relays are shown that relate to a particular function. Trouble record punch indications are shown at the point in the sequence when ground is applied to or removed from the lead to the trouble recorder. Trouble analysis sequence charts omit relays shown on the regular sequence chart except those relays associated with the trouble record designations (SFD A103). A designation on the trouble analysis sequence chart without a punch symbol indicates the point in the sequence where that designation would be punched if a trouble record were taken. A designation with a triangle (base down) to its right indicates the point in the sequence after which a designation would not be punched.

G0-1.1 USE OF FLOWCHARTS AND TROUBLE ANALYSIS SEQUENCE CHARTS

These paragraphs will demonstrate the use of the flowchart (SFD-G002) and the trouble analysis sequence chart (SFD-G003). A crafts person experienced in the use of trouble record cards may find this section basic, but the procedures shown here (even though they may become automatic) are the procedures a qualified crafts person must perform.

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† Symbols used in flowchart are described on SFD-A103.

Without a selection of trouble record cards to distribute to the reader, certain functions must be assumed. It is assumed that all trunks, trunk links, line links, senders, etc, vary. The only equipment that remains the same on all cards is the marker. Following the flowchart (SFD G002), it is identified that the MXT punch is not indicated. The path to follow is marked No (N). The WT punch is indicated on the trouble record. The path to follow is marked Yes (Y). This procedure continues through the FCG N, the GT5 N, TK Y, the HMS1 Y, and the DCT1 N. The flowchart directs the reader to SFD G003. The trouble analysis sequence chart, and all sequence charts, operate from the top of the page to the bottom. To identify the trouble area the reader must start at that point of major failure and backtrack to the point where all punch indications (leading to the branch in trouble) are shown.

To demonstrate the procedure when analyzing a trouble record in the tandem office (SFD-G003): Working back from the DCT1, the GT2 is indicated, the DCT is indicated, and the AVK1 is not indicated. (The reader must now follow the path from the AVK1.) The RSC is indicated, the SLK2 is not indicated, and the SLK1 is indicated. There are no other paths leading to the SLK2. The problem exists between the SLK1 and SLK2 indications. The page coordinate at A7 shows the portion of the trouble analysis sequence chart that is shown in detail on C202. Use of the sequence chart on C202 will be described in G0-2.

G0-2 SEQUENCE CHARTS

The sequence charts used in the SFD follow standard conventions for sequence charts, except as stated on SFD-A103.

The example in G0-1.1 demonstrating the procedure used when analyzing a trouble record in the tandem office is continued on SFD-C202. The SLK relay checks that the SHKA operates. The relays now involved are the SH hold magnet OSL, ON, CT, and LR relays in the sender, D and TM in the trunk, and the release of the SLK in the marker. Caution is necessary at this point. When conditions were established for this example, the only equipment that remained unchanged on all the cards was the marker. One might assume that relays in the senders, trunks and OSL (and their operations) could be eliminated. However, this is definitely not true. The physical wiring and apparatus can be eliminated, but the lead to operate the TM relay in the trunk extends to the marker and cannot be eliminated. The TM relay should be checked to see if it operates, and then the path to the SLK2 checked.

GO-3 CROSS DETECTION, SEQUENCE FAILURE (SFD-G002)

For either of the double sided trouble cards, there is an MXT designation which is punched if there is a cross detected (X--) or if there is a Sequence Failure (SQA) of the junctor walking circuit. For the single sided trouble card, there is no MXT punch and it is necessary to scan all the X-- designations and the SQA designation to determine if there is a cross or sequence failure. The reader should proceed through each decision box following Y if the designation is punched or the statement is true, or N if the designation is not punched or the statement is not true. If there is no MXT or SQA, cross or sequence failure, the procedure beyond that point is the same for all trouble record cards.

GO-4 TIMING FUNCTIONS

The DTM and CM are designed in such a way that they are timed from seizure until release. Critical functions are timed separately. Understanding the purpose and function of timing circuits will aid the crafts person in understanding the behavior of the marker. General functions of the OAT, WT, SDT/LDT, and TRS timers will be discussed in this section. More detailed description of timing operations can be found in the SCD-C1 section.

GO-4.1 OVERALL TIMER (OAT)

The OAT is started when the CM is seized and is stopped when the marker is restored to normal. The timing interval is 9.6 to 15.4 seconds which is greater than the time required on any normal marker usage. This timer guards against failure of any of the other timers. Operation of the timer causes the marker to release without a trouble record but will sound a major alarm.

GO-4.2 WORK TIMER (WT)

The WT timer is started when the marker is seized and is stopped when the marker is restored to normal. The timing interval is 450 to 605 milliseconds. This short timer is used to detect trouble as soon as possible in order to quickly release the marker. The WT timer is recycled as the call progresses. Operation of the WT causes the marker to take a trouble record before releasing and will be the timer that will most often generate a trouble record.

GO-4.3 SHORT DELAY TIMER (SDT) AND LONG DELAY TIMER (LDT)

The SDT provides a delay of 2.6 to 4.5 seconds on service calls and 1.1 to 1.9 seconds on no-test calls. The LDT provides a delay of 4.6 to 7.5 seconds. Both timers are started by the operation of the Seize Frame (SF) and Seize Frame Timer (SFT) relays. The operation of the SF stops the WT timer. The SF and SFT relays operate when the marker closes a start lead to select a frame such as the LL, TL, NG, OSC, or FAT. The SF and SFT relays also operate on various test calls and on completion of the sender trunk guard test. The SDT timer always functions first unless the trouble recorder is busy. This condition requires the longer timing provided by the LDT. If the SDT should fail, the LDT, which is also timing will function as a backup.

GO-4.4 TRANSFER START TIMER (TRS)

The TRS circuit functions to transfer the marker connector start leads to the alternate marker preference whenever a marker is not seized in approximately 1.0 second. If the WT, SDT/LDT are not punched and the TRS is punched, the trouble record indicates that the marker connector could not connect to a CM within the transfer start timing interval and had to transfer its start leads.

GO-5 FALSE CROSS-GROUND TEST (FCG)

The FCG is the next punch designation which must be considered on the flowchart (SFD-G002) and will be discussed briefly at this time. During light traffic conditions the CM operates all hold magnets except the line hold magnet. The FCG relay is connected to the tip and ring leads and will operate if there is a cross between the tip and ring, a false ground on the ring conductor, or a false battery on the tip conductor. The FCG relay will lock operated, stop the marker progress, and force a WT time out.

GO-6 LINK RELEASE (LR) WITH OR WITHOUT DCK

Since the Incoming Register Link (IRL) circuit contains no timing feature and since a link failure would block calls from numerous incoming trunks, the Incoming Register (IR) is arranged to time for completion of link functions and to cause a Completing Marker (CM) connection and release of the IR if they are not completed within 325 milliseconds nominal. Timing is accomplished with the Link Release (LR) tube, LR relay, and the associated capacitor-resistor network.

The LR relay function in the IR, grounds the LR lead to the CM, so that the CM can take appropriate action. If the DCK is operated, it indicates that a link crosspoint has been closed and that no double connection exists. If the DCK is not operated and the LR is operated, the IRL failed to pass information through its cross-connects to the IR.

SECTION G, PART 1

INCOMING TANDEM TRUNK SEIZURE, INCOMING REGISTER SELECTION AND PULSING

Index

		PAGE
G	ESTABLISHING INCOMING TANDEM TRUNK CONNECTION	G1-3
G1	INCOMING REGISTER SELECTION AND PULSING	G1-5
G1-1	TRUNK AND REGISTER PREFERENCE	G1-5
G1-2	OPERATION OF TRUNK PREFERENCE RELAYS	G1-6
G1-3	SELECTION OF IDLE REGISTERS	G1-6
G1-3.1	OPERATION OF REGISTER PREFERENCE	G1-7
G1-3.2	CLOSURE OF SWITCH CROSSPOINTS	G1-7
G1-3.3	REGISTRATION OF INCOMING TRUNK CLASS	G1-8
G1-3.4	REGISTRATION OF TRUNK LINK NUMBER	G1-9
G1-3.5	REGISTRATION OF TRUNK NUMBER	G1-10
G1-4	REGISTRATION PULSING, MF	G1-11
G1-4.1	PREPARATION FOR RECEIPT OF PULSES	G1-11
G1-4.2	PULSING PATH DESCRIPTION	G1-12
G1-4.2.1	MF Frequency Chart	G1-12
G1-4.3	MF RECEIVER CIRCUIT SD-95536-01	G1-13
G1-4.4	DIGIT REGISTRATION	G1-13
G1-4.5	DIGIT STEERING CIRCUIT	G1-13
G1-4.6	REGISTRATION OF THE "A" DIGIT	G1-14
G1-4.7	REGISTRATION OF THE "B" DIGIT	G1-14
G1-4.8	PULSE CONSISTING OF MORE THAN TWO FREQUENCIES	G1-15
G1-5	REGISTER PULSING DP	G1-15
G1-5.1	GENERAL DESCRIPTION	G1-15
G1-5.2	TYPES OF TRUNK PULSING	G1-15
G1-5.3	LINK CONTROL	G1-15
G1-5.4	DIGIT COUNTING AND REGISTRATION	G1-16
G1-5.5	TRUNK CLASS	G1-16
G1-5.6	ABANDONED CALL TIMING - DIRECT PULSING TRUNK	G1-17
G1-6	REGISTER AND LINK TIMING	G1-17
G1-6.1	TIMING DESCRIPTION	G1-17
G1-7	SELECTION OF REGISTER BY AMRST	G1-18
G1-7.1	MONITOR PREPARATION	G1-18
G1-7.2	PARTICULAR REGISTER SELECTION	G1-19
G1-7.2.1	Selection With Incoming Register Link	G1-19
G1-7.3	PROGRESS LAMPS	G1-20

G1-8	STANDING CROSS RELAY TROUBLE INDICATION	G1-20
G1-9	MASTER TRAFFIC CONTROL	G1-21
G1-9.1	GENERAL DESCRIPTION OF OPERATION	G1-21
G1-9.2	CONTROL OF TRAFFIC THROUGH INCOMING REGISTER MARKER CONNECTORS	G1-21
G1-9.2.1	Circuit Normal	G1-21
G1-9.2.2	Single Request for a Marker - No Gating	G1-22
G1-9.2.3	Overlapping Requests for Marker - Gating	G1-23

G ESTABLISHING INCOMING TANDEM TRUNK CONNECTION

Incoming calls may be received from an operator or from a calling customer in a connecting office. The digital information is received by the IR which is connected to the CM through the Incoming Register Marker Connector (IRMC). The CM will determine from the information passed to it from the IR whether to process the incoming call as a terminating call or a tandem through switched call.

A tandem through switched call is one in which a subscriber from a distant originating office attempts to complete a call to a subscriber in a distant terminating office. Since it is not economically feasible to have direct trunks between all central offices, intermediate switching points or tandem offices are provided to handle the traffic between offices that have no direct connections. This type of operation is known as tandem switching.

A No. 5 crossbar office can be used to provide this tandem switching service in addition to its regular functions. An incoming trunk arranged for handling tandem traffic at a No. 5 crossbar office with tandem switching features can also handle local traffic for completion to this office since it is generally more economical to combine these two types of traffic over the same trunk group. To permit this dual use, it is necessary to provide such trunks with both trunk link and line link frame locations. The trunk link frame location is for local completing traffic and the line link location is used when the call is to be switched through the No. 5 crossbar office.

The general sequence of operation of establishing a tandem switching connection is as follows:

The closure of the loop from the outgoing sender in the distant office to the incoming trunk causes the A relay to operate in the incoming tandem trunk. This A relay closes battery to the Incoming Register Link (IRL) and in response to this signal, the IRL functions to connect an idle IR to this trunk.

The IRL sends to the IR information consisting of class of trunk and the trunk number of the incoming tandem trunk. This information will be used by the CM in processing the call. A crosspoint is closed in the IRL to connect the IR to the trunk. When this connection has been established, all checks satisfactorily completed, and a timed interval has passed, the IR takes control of the connection, reverses the tip and ring leads to signal the distant originating office that the IR is ready to receive pulses.

The IR may be of two types, Dial Pulse (DP) or Multifrequency (MF). For DP, the signal is passed directly to the IR where it is stored to be passed to the CM. For MF, the signal (two frequencies) is received by a signal receiver, which converts the signal to direct current to be used by the office. These signals are also stored by the IR to be passed to the CM. After the IR receives all digits, it prepares the trunk to assume control of the connection. The IR then establishes a connection to the CM through the IRMC and passes information to the CM that is used to complete the call.

When a CM has been seized on a call of this type, the marker connects +130 volt battery to lead F operating relay TF in the tandem trunk. The primary function of relay TF is to keep the sleeve holding ground provided by this circuit on through calls, from interfering with marker operation in setting up the connection to the outgoing trunk. The CM determines from translation of the dialed number and other input information received from the IR the required route, and determines what type of sender is needed.

The CM connects to a sender through the outsender connector and transfers digit, delete and outpulsing information. The CM performs several functions at the same time. Two of these functions performed at approximately the same time are sender and trunk operations. After the marker selects the trunk, and the F relay operates (Section G4), the marker closes a path from the sender to the trunk through the outgoing sender link frame. While the sender connection is being established (Section G3), the completing marker proceeds to select a trunk link having an idle trunk of the correct type. It then proceeds to select and connect to a trunk.

Another function of the CM performed at this time is the translation of the incoming tandem trunk number to a line location. The trunk number is an arbitrary 3-digit number (000-999) assigned to each trunk for the purpose of obtaining a line link location. The CM seizes the proper number group through a number group connector and obtains the line location of the tandem trunk. The CM then seizes the line link frame on which the incoming tandem trunk appears via the line link connector.

The line link containing the line location of the tandem trunk is seized to enable the CM control of the desired select and hold magnets. This connection is referred to as Call Forward Linkage (FLG) and is used on Tandem (TAN), (Incoming Terminating (INC TER), and Intraoffice (IAO) type calls.

Following hold magnet operation, the channel is checked for crosses, continuity and double connections. The sender and trunk information is checked to insure its proper transmission. Connections between the line location of the tandem trunk and the OGT are made by closing the line switch and junctor switch crosspoints on the LL, and the junctor switch and trunk switch crosspoints on the TL. The select magnets and hold magnets involved in closing the specific crosspoints depend on the location of the line on the line switch, the trunk on the trunk switch, and on the channel selected.

Upon the successful completion of the double connection test and the ground test, the CM transmits an advance signal to the outgoing sender as an indication that the outgoing sender should assume supervision and complete the call. The marker then checks the functions in the outgoing sender, that the linkage is properly set up, and releases. The outgoing sender, having prepared the distant register to accept pulses, awaits a signal from the distant end and starts outpulsing. After all digits are outpulsed, supervision of the call is turned over to the incoming tandem trunk, and the sender is released.

G1 INCOMING REGISTER SELECTION AND PULSING

G1-1 TRUNK AND REGISTER PREFERENCE

The general overview of sheet G104 shows the TP- relay operation, selection and hold magnet operation in relation to the IRL and the incoming trunk. The association of TP00 to the Automatic Monitor Register Sender Test (AMRST) circuit is also shown. The IRL basic and supplementary switches of the first, intermediate, and last horizontal groups are shown with their associated select and hold magnet leads.

The interconnecting leads ST, RB, BL, LK, and SM- are carried over to sheets G106 and G107 which show the incoming registers and their association with register preference between the different horizontal groups on the IRL frame.

Register preference shown on sheets G106 and G107 are layed out in block diagram style and alphabetized to indicate first, intermediate and last appearances in the horizontal group of the IRL frame. Block diagrams are shown of the different appearances of incoming registers 0 through 9. Refer to Notes 1 through 5 on sheet G107 for explanation and proper use of the multiple leads and preference blocks in relation to chain circuit leads and preference chains. The vertical blocks A through C

are associated with the incoming register designated E at the bottom of each row. A combination of the same blocks in horizontal rows are associated with the horizontal groups. Therefore work chains and preference chains can be followed to the end.

On SFD-G105 a block diagram can be used to trace through the incoming register link chain circuits. The colors used are red for the ST lead chain, blue for the B (B, B1, and B2) lead preference chain, and green for various work chain leads (SFD-G105).

G1-2 OPERATION OF TRUNK PREFERENCE RELAYS (SFD-G104)

When an incoming trunk requires connection to a register it connects battery on the ST- lead to operate its Trunk Preference (TP-) relay as shown in G104.

Since all the TP- relays in a horizontal group are in a chain of preference, only one trunk can proceed at a time. The operation of a TP- relay such as the one shown for an intermediate trunk opens ground from the windings of all the higher numbered TP- relays. Lower numbered TP- relays may operate but can do no work since all of the work leads are in a chain running in the opposite direction and these are opened at higher numbered relays. If during the time one call is being served and other TP- relays operate, these trunks will be served in order starting from the highest numbered. Trunks which cannot operate their TP- relays must wait until the last operated TP- relay is released before being served.

G1-3 SELECTION OF IDLE REGISTERS (SFD-G106,G107)

The register control circuit consists of relays Register Preference (RP-) and Register Busy (RB-) which are furnished one per register per horizontal group. The RP- relays carry a number of work leads in chains and the RB- relays perform the function of controlling the start lead from the TP relays.

A ground from the operated TP- relays (SFD-G104) is furnished to prepare the operation of the RP- relay of the first idle register in the chain of preference over the ST lead through the RB- relay contacts (SFD-G106).

On SFD-G106, note that the battery for operating the RP- relays is supplied by the associated incoming register over the B lead and then taken through a chain of contacts on the RP- relays associated with that register. To simplify this arrangement of multipling between other

registers on link switch levels an arbitrary lead designation has been shown. For example, B lead from block A splits into two leads designated B1 and B2 for easier reference of chain operation. Block A represents the start of the preference chain and end of the work chain. Block B is an intermediate representation of both chains, and Block C represents the start of the work chain and end of the preference chain.

G1-3.1 OPERATION OF REGISTER PREFERENCE

The operation of a RP- relay prepares a path for the operation of C- relay over TF lead from incoming register. Note here that the battery side of C relay has been given the arbitrary designation C lead as it multiples between other horizontals and finally connects to the B or battery supply from the incoming register in Block A on sheet G106.

If the preferred register is idle, its register preference relay operates; but if it is busy, its register busy relay will be operated advancing the start lead to the succeeding register.

The operation of the RP- relay constitutes seizure of the register. The register preference relay operates an Off-Normal (ON) relay in the IR which prepares the register for operation. A Register Busy (RB) relay in the IR operates which causes operation of link register busy relays for this register in all other horizontal groups. Operation of the RB relay in the IR operates the RB- relays in the IRL on all horizontal groups except the one being served. The RB- relay in the selected horizontal group is held shunted down by ground on the LO lead until the RLK relay in the IR operates to allow the RB- relay associated with the IR in the IRL to operate.

G1-3.2 CLOSURE OF SWITCH CROSSPOINTS (SFD-G104)

Operation of the register off normal relay and an IRL select magnet closes a circuit through the operated trunk preference relay to operate the hold magnet for the trunk being served. This operating ground is extended through crosspoints to operate relay H which opens the circuit through the trunk preference relay and closes the circuit to the Double Connection Check (DCK) relay. The DCK operates unless there is a ground already on the crosspoints which would occur if two crosspoints were closed to the same register. The DCK would be shunted down and a marker would be called in for a trouble record. Otherwise, this DCK locks and the hold magnet is held over the HM lead through the crosspoints. The operated H relay releases the select magnet.

On TAN calls, a check is made that the trunk number information has been received from the link, by placing contacts of the REG, REG1, SUP, SUP1, LT-0-9, and the LUT relays in the operating path of the CK relay. The LUT in operating checks that a ground has been received on one of the LU- leads indicating that the register link is functioning satisfactorily. The marker when connected at the completion of digit registration will check for the operation of the second LU- relay.

G1-3.3 REGISTRATION OF INCOMING TRUNK CLASS (SFD-G108)

The IRL sends to the IR information consisting of class of trunk, trunk link frame number and trunk location for translation to a trunk number (if a trunk number is required). This information sent to the IR will be used by the CM to establish a connection to the incoming trunk.

The RP- relay in the IRL operates associated relays designated C and CA from ground on the TF lead.

One out of eleven leads is grounded by an operated TP- relay to indicate the trunk class to the register. In all cases except for Phase I and II centrex transfer type trunks and 2-way operator office trunks the class indication is determined by a cross-connection from TPC- to CL00-10. The other end of the 11 leads CL00-10 are brought out to the register frame for cross-connection to nonspecial and special class combinations. The designation of these cross-connection punches are as follows:

OA - Where four digits calls are received for termination in office A.

OB - Where four digits calls are received for termination in office B.

AB - Where five digits calls are completed and the initial digit indicates the required office number.

OAS - Same as OA for calls received on a special call basis (OPR and local test desk).

OBS - Same as OB for calls received on a special call basis (OPR and local test desk).

ABS - Same as AB for calls received on a special call basis (OPR and local test desk).

TAN - Tandem calls are received and the trunks transmit all the digits of the office code and no screening or restrictions apply.

TAN1 - These classes may be assigned to any of the following types
TAN2 of trunks:
TAN3
TAN4

a. Five Digit (FVD) tandem calls are received and the trunks transmit only one digit of three digit home area codes.

b. Six digit, 2DT tandem calls are received and the trunks transmit two digits of three digit home area office code.

c. Tandem calls are received and the trunks transmit all the digits of the office code and screening or restrictions apply to some calls.

G1-3.4 REGISTRATION OF TRUNK LINK NUMBER (SFD-G109)

Similar to class registration, trunk link information is furnished by grounding one of 40 TPU- cross-connection punchings, which represent the location of the incoming trunk in the incoming register link. The TPU- to TFU- cross-connect is determined by the units digit of the trunk link frame on which the incoming trunk is located.

The FG- to G- cross-connection is determined by the horizontal group and FG (or tens digit) of TL frame number on which the incoming trunk is located. The FG0-2 leads are connected directly to the corresponding FG0 to FG2 relays to determine the proper horizontal group information in the incoming register.

One of the leads TF0 to TF9 in the incoming register will be grounded on each call, when the connecting relay of the IRL horizontal group associated with the selected incoming register operates. This TF- lead causes operation of 1-out-of-5 TF- relays in the IR. The one TF-2/5 relay, in operating, locks and operates the Trunk Frame Transfer (TFT) relay which transfers the incoming TF lead from the one TF-2/5 relay to another TF-2/5 relay. The two TF2/5 relays connected to each lead have the numerical designation of the lead. For example, a ground on lead TF2 will initially cause operation of relay TF2. The TF2 will operate TFT which connects lead TF2 to relay TF0, operating the TF0 relay.

Each of the operated TF- relays will ground a correspondingly numbered lead to the marker connector. A contact of TFT is placed in the CK relay operating path to insure that TFT is operated. This insures that a ground has been received on one of the TF- leads. If a ground is not present on one of the TF0-9 leads, TFT will not operate and the Link Release (LR) timer will function to cause connection to a marker with a LR failure indication. If a trouble record is taken at this time, it will indicate the link groups involved in the call.

G1-3.5 REGISTRATION OF TRUNK NUMBER (SFD-G110, G111, G112)

In order that the marker can determine the location of the line link frame appearance of tandem trunks, each trunk with a line link appearance is assigned a three digit number representing a hundreds, a tens, and a units digit. The marker uses a preassigned thousands digit and this three digit number to obtain the desired location from the number group. This three digit number is assigned by cross-connections applied in the register to terminals associated with the trunk location relays.

Each trunk is identified by three marks: the frame group, the link or half switch tens, and the link or vertical unit. Each trunk can be given a distinctive number provided at least one item of information concerning these three marks is different from that for all other trunks.

The frame group marks are REG and SUP and functionally take their designation from the U-type link where the entire frame was assigned to the same mark. On the U-type link one of the two basic frames was assigned to the REG mark and one of the two supplementary frames were assigned to the SUP mark. In the wire spring link the frame group makrs are cross-connectible within each frame and within the basic and supplementary switch divisions on a horizontal group basis and any horizontal group can be assigned to give either the REG or SUP mark.

The link or half switch tens mark comes from the physical location of the trunk on the register link. The trunk groups are divided into half switches or subgroups of ten and are numbered from 0 to 9. The basic switch of horizontal group 0 comprises the link tens subgroup 0 and 1, the basic switch of horizontal group 1 comprises the link tens subgroup 2 and 3 etc to horizontal group three. These link tens subgroups are duplicated in the supplementary switches (see SFD-G111). The link or vertical unit mark comes from the physical location of the trunk in the half switch or subgroup of ten and is the same as the units number of the corresponding TP relay. When the register is seized the C- and CA-relays of the wire spring register link operate or the CL and TN relays of the U-type register link operate (SFD-G138) causing operation of the frame group relays REG/SUP/REG1/SUP1 (SFD-G112 and G134) one of the relays LT-(0-9) (SFD-G111 and G128) and two of the relays LU-(0-9) (SFD-G110,G129) to transfer the trunk number to the IR.

The units digit is not cross-connectible and is the same as the vertical unit position of the trunk on the half switch. The units digit is registered on the LU0,1,2,4,7 relays on a 2-out-of-5 basis. The ground on 1 of the 10 leads LU-0-9 from the register link will operate

1 of the LU- relays and LU- relay will in turn operate the link units transfer relay LUT. This relay operated transfers each of the 10 LU- leads to a second LU- relay. Thus, the ground on the LU- lead will cause operation of 2 of the LU0,1,2,4,7 relays (see SFD-G110). The 2 LU- relays connected to each lead have the numerical suffixes of the 2-out-of-5 combination for the numerical designation of the lead. The LU- relays each have a make contact to ground a correspondingly numbered lead to the marker connector.

For trunks represented by the REG and SUP group relays full flexibility as to the hundreds number and the tens number is possible for each subgroup of 10 trunks since there are 4 terminals for each LT- relay for the REG assignment and 4 terminals for the SUP assignment. The pairs of TA- and TB- terminals for REG assigned trunks and the trunks are cross-connected on a 2-out-of-5 basis to the TT0-1,2,4,7 terminals to indicate the trunk tens number. The HA- and HB- terminals for REG assigned trunks and the EHA- and EHB- terminals for SUP assigned trunks are cross-connected on a 2-out-of-5 basis to the HT0,1,2,4,7 terminals to indicate the hundreds number.

For trunks on the register link switches assigned to the REG1 and SUP1 group relay a particular hundreds number must be assigned. The AHRA and AHRB terminals for trunks assigned to group relay REG1, and ASHA and ASHB terminals for trunks assigned to group relay SUP1 are connected on a 2-out-of-5 basis to the hundreds terminals HT0,1,2,4,7. The tens number assignment for trunks assigned to the REG1 group relay have full flexibility but the trunks in the corresponding subgroup of 10 trunks, represented by the same LT- relay assigned to the SUP1 group relay will have this same tens number. The pairs of ATA- and ATB- terminals are cross connected on a 2-out-of-5 basis to the TT0,1,2,4,7 terminals. For example, by cross-connecting ATA7 and ATB7 to TT0 and TT1, respectively, the tens digit one is assigned for trunks on the right half of the horizontal group three and represented by relay LT7, assigned in the register link to the REG1 or SUP1 group relays (see SFD-G215).

A typical cross-connection for registration of a trunk number in an incoming register is shown in detail on sheet SFD-G218.

G1-4 REGISTER PULSING, MF

G1-4.1 PREPARATION FOR RECEIPT OF PULSES

The RLK operates at the completion of the link functions. It opens the discharge path of the RV timing circuit and closes a charging path from the RV relay to the RV capacitor to start timing. The RV relay operates after 190 milliseconds nominal time and locks to its secondary winding.

The operation of relay RV reverses the polarity of the tip and ring leads to the outgoing trunk in the originating office. This signals the outgoing trunk or operator that pulsing should start. The register is ready to receive pulses at this time because relay ON1, which operated from the ON, has connected battery on leads BAT1 and BAT2 to the signal receiver circuit. The digit register has been prepared for registration of digits by operation of the first steering relay AS from the ON relay.

G1-4.2 PULSING PATH DESCRIPTION (SFD-G114-G115)

The SFD G114-G115 shows the complete pulsing path from the OSMF in the distant originating office to the end circuit MF receiver associated with the IR in the distant terminating office.

G1-4.2.1 MF Frequency Chart

Each digit transmitted by multifrequency consists of a pulse of 2-out-of-5 audio frequencies. These frequencies are 700, 900, 1100, 1300, and 1500 cycles per second, designated 0, 1, 2, 4, and 7 respectively. In addition, a key pulse using frequency 1100 and 1700 cycles is transmitted as a gate opener. Also, a start pulse using frequencies 1500 and 1700 cycles is transmitted after the last digit as a start signal for the terminating IR to complete its function. The entire code digits used are as follows:

MF Frequency Chart

Digit	Designations	Actual Frequencies Cycles per Second
0	4, 7	1300, 1500
1	0, 1	700, 900
2	0, 2	700, 1100
3	1, 2	900, 1100
4	0, 4	700, 1300
5	1, 4	900, 1300
6	2, 4	1100, 1300
7	0, 7	700, 1500
8	1, 7	900, 1500
9	2, 9	1100, 1500
KP	2, 10	1100, 1700
START	7, 10	1500, 1700

G1-4.3 MF RECEIVER CIRCUIT SD-95536-01 (SFD-G116)

The receiver circuit is maintained in a disable condition until it receives the key pulse (gate opener) so that it will not react to unwanted signals that may appear on the line due to inductive pick up. The KP signal is received entirely by the signal receiver without operating relays in the register. Each subsequent digit causes the receiver SP (signal present) tube and relay to operate. The SP relay in turn causes operation of receiver relay LK over the leads J and L, shown on SFD-G117. The LK relay connects +130 volt battery to the receiver channel relays and when the channel thyratron tubes (corresponding to the frequencies received) operate causes associated receiver channel relays to operate. The operation of two channel relays ground the corresponding leads 0, 1, 2, 4, or 7 causing operation of the corresponding A2/5-L2/5 digit register relays and also operates the RA relay over the S lead, shown on sheet SFD-G116 and G117. The operating path of the receiver channel relays includes the winding of the receiver relay CK2 which operates and causes operation of register relay 2CK over lead H.

Operation of RA operates the next digit steering relay and with 2CK operated opens the J and L leads to the receiver which releases relay LK. The release of LK releases the channel relays and relay CK2. If by this time the signal is ended, relays 2CK and RA release and allow release of the steering relay for the digit just received. If, however, the signal pulse is still present, relays RA and 2CK will be locked to the receiver signal present relay SP over lead J. These interlocking features are provided to insure that each pulse locks in until it has been recorded and that the register does not advance to the next digit until the end of pulse.

G1-4.4 DIGIT REGISTRATION (SFD-G117)

The digit register unit consists of a dry reed relay pack with five independent coils enclosed in a can and with each coil associated with two make contacts. One terminal of each of the coils is wired internally to one of its associated contacts for locking purpose and a single lead is wired to a terminal. One contact of the locking contact pair, one terminal of the coil and both contacts of the load contact pair are wired to individual terminals. These terminals extend to both front and back of the dry reed relay pack for ease of wiring and testing. Also for ease of wiring, three sets of terminals are strapped internally. These terminals are the battery side of the coils, the locking contact of the relays, and one side of the load contacts.

G1-4.5 DIGIT STEERING CIRCUIT (SFD-G117)

The digit steering circuit consists of a single relay per digit AS-LS. Each steering relay is advance by a contact on the Register Advance (RA) relay. At the time of seizure, the register relay ON operates in turn operating the AS which locks through series back (break) contacts of all

the steering relays. The RLK opens the operating circuit of AS. On the first operation of RA, the BS relay operates through contacts of AS. The BS locks through a back contact of CS and opens its operating circuit on one set of continuity transfer contacts. The BS, on another set of continuity transfer contacts, transfers the locking circuit of AS from the ON ground to the RA controlled ground so that when RA releases AS will release. The next operation of RA will operate CS through back contacts of AS and front contacts of BS and the next release of RA will release BS. This action continues with each operation of RA operating the steering relay for the next digit and each release of RA releasing the steering for the digit just registered.

G1-4.6 REGISTRATION OF THE "A" DIGIT (SFD-G117)

The A Digit Steering (AS) relay is operated from the ON relay when the register is seized. When the A digit frequencies enter the receiver, the MF receiver Signal Present (SP) tube and relay operate. The SP connects ground on lead J which is connected through back contacts on relays MST, TEN, STS (and depending on the number of digit registers equipped), BS, DS, FS, HS, and KS to lead L to the winding of receiver relay LK. The steering relay part of this path is paralled by a circuit through a back contact of 2CK. The LK operates and connects battery to the receiver channel relays and when the channel thyratron tubes (corresponding to the frequencies received) operate cause associated channel relays to connect ground to corresponding leads to the register. These grounds are carried through the contacts of AS relay to operate the corresponding A digit register relays which lock.

When the receiving circuit detects one or more frequencies, the corresponding numerically designated relays of the receiving circuit operate and cause operation of RA over lead S. When the receiver circuit detects two frequencies and two of the numerically designated relays operate, the receiver CK2 relay operates causing operation of the 2CK relay. Both RA and 2CK lock to the J lead which is controlled by the SP and the CK2 relays of the receiver. The RA operates BS which opens one leg of the circuit between the J and L leads in the register and when 2CK operates the J lead is disconnected from the L lead allowing release of the LK relay of the receiver. The LK, in turn, releases the receiver CK2 and numerically designated relays. If the signal pulse has ended or when it ends, SP will release. With both SP and CK2 released, RA and 2CK will release. The RA, in releasing, completes the steering advance by causing release of AS which recloses one leg of the circuit between the J and L leads. The release of 2CK relay recloses the other leg of the circuit between the J and L leads. Either leg being closed enables the relays of the receiver to respond to the next digit signal.

G1-4.7 REGISTRATION OF THE "B" DIGIT

The B digit is recorded in the same manner described for the A digit. When the frequencies are detected, the receiver SP relay operates. The LK relay operates to enable the receiver channel relays. Two of the

channel receiver relays operating will cause operation of CK2. Register relays RA and 2CK operate the steering relay CS to open the J and L leads to relay LK which, in turn, releases the receiver channel relays and CK2. The B digit register relays operate from the receiver channel relays. Subsequent digits are received and recorded in a similar manner.

G1-4.8 PULSE CONSISTING OF MORE THAN TWO FREQUENCIES (SFD-G116)

If a trouble condition exists that causes more than two receiver channel relays to operate, the current drawn by the receiver channel relays will exceed the minimum required to operate the receiver relay CK3. Operation of CK3 grounds lead RO which operates the Reorder (RO) relay. The RO relay causes the marker to be seized with a reorder indication.

G1-5 REGISTER PULSING, DP

G1-5.1 GENERAL DESCRIPTION

The dial pulse incoming register is used to receive information in the form of dial pulses over a trunk from another office and when the entire number is received to transfer this information to the marker so that a connection can be set up between the incoming tandem trunk and the OGT arranged for tandem.

G1-5.2 TYPES OF TRUNKS

The register is arranged to receive pulsing from two different types of trunks. Bylink pulsing trunks are those originating principally in step-by-step offices on which pulsing may start soon after the trunk is seized. For these trunks an early or bylink pulsing path is established through the control relays of the IRL to carry the pulsing signals until the IRL switch contacts close the regular path. Direct pulsing trunks are those on which pulsing will not start until a signal, either dial tone or a trunk reversal, is returned by the register. When a direct pulsing trunk is connected to the register a relay is operated in the trunk which gives the register sole access to the tip and ring from the calling office and it receives pulses directly from that source. All trunks on a particular IRL switch must be of the same type in respect to the type of pulsing (SFD-G134-G135).

G1-5.3 LINK CONTROL

In cooperation with the IRL circuit the register establishes a connection from the trunk to the register through the IRL switch contacts, checking that there is no double connection. The register prepares to receive pulses and distinguishes whether the connection is to a bylink or direct pulsing trunk. After all required information has been received the IRL control relays are released. If a direct pulsing trunk

is connected to the register, the battery and ground supplied by the register to the tip and ring of the trunk are reversed after a time interval and dial tone is connected when required by the trunk circuit as a start pulsing signal.

G1-5.4 DIGIT COUNTING AND REGISTRATION

The register then counts the number of pulses in each digit and when the dialing is completed transfers this count to the digit register and recycles to make itself ready for reception of the next digit. By recognizing the start and completion of each digit it controls the progress of the register steering circuit. A digit register unit with five elements is provided for each digit, better known as reed type storing relays. These relays operate on 2-out-of-5 basis. A steering circuit which is controlled by a RA1 (register advance relay) progressively associates the register units with the counting circuit as digits are received. The steering circuit consists of one relay for each group of register relays (AS, BS, CS, etc.).

G1-5.5 TRUNK CLASS

When all digits have been received the register operates the Marker Start (MST) relay to start seizure of a marker. The steering relays are used to indicate when particular digits have been registered. As these relays operate they ground the C to L terminals with the terminal designation corresponding to a digit being grounded following registration of that digit. For example, when the D digit is registered, the ES relay is operated to ground 0 terminal. These terminals with their cross-connections, and in some cases permanent wiring to contacts of the class relays (OA, OB, and AB) are used to operate the MST relay. Since the register does not receive the same number of digits from all incoming trunks, the operation of MST is controlled either directly or indirectly by the class relays. For instance, for a four digit local completing incoming trunk with the OA class relay operated, the MST will be operated when ES operates after the fourth digit is registered. For a five digit local completing incoming trunk with the AB class relay operated, the MST will be operated when FS operates after the fifth digit is registered.

For tandem trunks, this class relay control is provided on a cross-connectible basis by the 11E- and 11F-terminals (see sheet SFD-G139).

The MST terminal is connected directly to the MST relay winding and a ground at this terminal will cause selection of the marker without delay.

G1-5.6 ABANDONED CALL TIMING - DIRECT PULSING TRUNK

The abandoned call timing in the dial pulse register is accomplished with the AC cold cathode tube, AC relay, and the associated AC resistors and timing capacitor. The AC capacitor is discharged between calls through normal contacts of the BL and CK relays and the operation of CK opens this path.

After the line reversal start dialing signal is transmitted, the L relay is under control of the calling office and L relay controls the ACC relay. During the dialing of each digit, the L relay will release to open the circuit to ACC. The ACC may or may not release depending on the length of the open pulse but if it does release it will reoperate on the next closure. The time of the timer is such that it will not operate on the longest dial open but will operate if L and ACC remain normal somewhat longer than the time of the longest dial open indicating that the call has been abandoned.

After all the digits have been registered, the L and ACC relays will release but TC1 will operate to prevent the timer from functioning. If the call is abandoned after TC1 operates, the release of TC1 will cause operation of the timer. If the discharge shunt around the AC capacitor is removed for a nominal time of 190 milliseconds the tube ionizes and AC operates. The AC relay operates the MRL to cause release of the register.

G1-6 REGISTER AND LINK TIMING (SFD-G118)

G1-6.1 TIMING DESCRIPTION

Since the IRL circuit contains no timing feature and since a link failure would block calls from numerous incoming trunks, the register is arranged to time for completion of link functions and to cause a marker connection and release of the register if they are not completed within a nominal timing period.

When the register is seized, two trouble condition timers are started. These are the Link Release (LR) and the TM (overall timer). The LR timer will detect a trouble condition which prevents the IRL from completing its functions and indicate this to the CM so that appropriate action can be taken.

The RLK relay, when operated, cancels the LR timer. The two key relays that must be operated to satisfy RLK operation are the CK and DCK. The CK relay operates if all class information is received properly from IRL and DCK will operate if no problems are encountered with IRL switch linkage.

The overall timing in the register is accomplished by the TM relay, TM tube, and the associated resistor-capacitor network. A period of 25 seconds nominal is allowed for all digits to be recorded. If MST (marker start) relay does not operate within the interval (after register seizure) the register will time out and call in a marker for a reorder connection. Once MST has operated, a second period of 25 seconds nominal is allowed for completion of the marker functions and register release. If the register does not release within this interval, an abandoned call is simulated in an attempt to release the register. In case the register fails to release, the office alarm is operated.

G1-7 SELECTION OF REGISTER BY AMRST (SFD-G120-G121)

G1-7.1 MONITOR PREPARATION

Before the AMRST is connected to the register to be tested, it is necessary to prepare the AMRST (monitor) for testing. The Incoming Register (IR) key should be operated, followed by the operation of the STT key. This operates the STT relay which serves as a general off-normal relay for testing operation of the monitor. The number to be pulsed is set up on keys or switches on the MTC circuit. The particular test and pulsing conditions are also set up on the keys or switches as necessary.

The number of the register in its IR link group is set up by setting the corresponding numbers on the SRS switch or SRS key. The number of the incoming register group is then set up by setting the IG- switch or operating a IG- key to the position numbered to correspond with the number of the incoming register group in which the register to be tested is located. Ground from STT relay contacts through the IG- switch or IG- key operates the MIR1 relay for multifrequency group. The MIR1 relay operation creates a path for operating all the SPR- relays. The SPR- relays open the paths by which the IRP- relays are operated from the incoming links. The PC- relay operates through the SPR- relay selected by the IG switch or by an IG- key. The PC- relay connects the windings of the 10 IRP- relays of its incoming register group to positions 0-9 on the SRS switch or to the 10 units on the SRS key.

If MIR1 operates, it operates MR and MF to prepare those circuits for multifrequency operation. The MIR1 also operates BT1 relay which connects battery to the N lead to the MTC circuit to make the start key of that circuit effective. When the start key is operated, it connects ground to operate the BT2 relay through the MIR1 relay. The operation of BT2 relay operates the IRP- relay associated with the register selected by connecting operating battery and ground for the IRP- relays through the operated PC- relays and SRS switch or key to ground. The BT2 relay also opens the operating path of BT1 relay.

G1-7.2 PARTICULAR REGISTER SELECTION

The IRP- relay, operating, will prepare the path for the operation of the M relay in that particular selected IR. The purpose of the M relay is to connect the IR to the test frame for monitoring or testing. If a call is in progress, the ground which holds ON relay operated will also hold the BT1 relay operated. When the register becomes idle, BT1 releases and closes ground to the IRP- relay contact associated with the last register.

For MF registers, MIR2 will operate through contacts of MIR1. The MIR2 relay serves as a cut-in relay for the leads from register to monitor previously closed at the register end by the M relay.

The relay BT1 is slow-release to extend the operate time of IRP- and M and also to permit the register to fully release before it is reseized. With the register now idle but held busy to service calls, MIR2 operates the IRST Incoming Register Start (IRST) relay to start selection of the register through the IR link circuit. When the register has been found to be idle, the IRST operates. The IRST relay supplies several off-normal grounds, one which lights the RB progress lamp, one which closes a circuit from battery through resistor ST, through a front contact of relay IRST, through back contacts of C, LKT, and BL1, through a front contact of an operated PC- relay to ST lead to the IRL and, through the winding of TP00 relay to ground. The complete operating path of TP- relay is found on SFD-G104.

G1-7.2.1 Selection with Incoming Register Link

Operation of relay TP00 in the IRL locks out all trunks in horizontal group 0 which have not already operated their preference relays. The test circuit must wait until all trunks which have preference relays operated have been served. When all preference relays of horizontal group 0 are normal except the test preference relay, the IRL grounds lead B, operating the associated trunk class relay TCL- (SFD-G121). This relay operates the associated lockout relays and operate register preference relays LO- and ORP-.

The LO- relay closes a register busy lead RB from ground through the primary winding of the RB1 relay to the register under test on a circuit through a back contact of RB2, back contact of C, front contact of IRST, through the SRS selector switch or key, front contact of LO-, the RB lead to the IRL, and the RB0 lead from the IRL link to the register. Since the register has been made busy by the test circuit, the register should have 226 ohm battery connected to lead RB, which will operate relay RB1. The RB1 relay locks operated on its secondary winding.

The RB1 relay operates relay RB2, which operates the preference relay in the IRL by connecting ground from a back contact of C relay, through a front contact of RB2, through the selector switch SRS or an operated key unit of the SRS key, through a front contact of relay ORP- to the RP lead in the link. The RB2 relay also changes progress lamps, lighting LO, and transfers the RB lead to the winding of relay RB3. The IRL RP- relay connects the RB lead to LO to the register, where there should be solid ground. The RB3 relay tests for this ground. If the ground is missing, the RB lead will be connected in the link and register to 100-ohm ground and 226-ohm battery. Since relay RB3 is supplied with 200-ohm battery and 100-ohm ground, it will operate if direct ground is connected to the register LO lead, but will not operate otherwise because it will then be in a balanced bridge circuit.

G1-7.3 PROGRESS LAMPS (SFD-G120)

When the RB3 relay operates, it locks operated, transfers the progress indications from lamp LO to lamp LK, and connects lead LK from the IRL to the winding of relay LK (SFD-G104). The register has resistance battery connected to lead LK, which will operate relay LK. This places the IRL connection under control of the register by connecting the LK lead to lead ST. The LK relay, in operating, transfers the progress indication from LK lamp to OH lamp and connects lead OH from the IRL to the winding of relay OH (SFD-G104). The register should operate its IRL select magnets and ground lead OH to the IRL. The select magnet off-normal contacts should close the OH lead through to the test circuit, operating relay OH. The OH relay locks operated and transfers lead OH from its winding to lead HM to the IRL, operating the test circuit hold magnet in the IRL.

The OH relay transfers the progress indication from lamp OH to lamp CO and closes an operating circuit for the C relay. The C relay locks operated, extinguishes the CO progress lamp, and connects D lead from the IRL to the winding of D relay. The subsequent operations depend on whether the test is bylink, dial pulse, or multifrequency.

G1-8 STANDING CROSS RELAY TROUBLE INDICATION (SFD-G119)

For either of the double sided trouble cards (1/X type CD-25805-01 or 2/5 type CD-27718-01), there is a MXT designation which is punched if there is a cross detected (X-) or if there is a SQA of the junctor walking circuit. For the single sided trouble card (1/X type CD-25805-01), there is no MXT punch and therefore it is necessary to scan all the X-designations and the SQA designation to determine if there is a cross of sequence failure.

After the particular cross relay operates, its contact sends a ground toward the MTFC circuit for trouble indication display through the trouble recorder circuit.

G1-9 MASTER TRAFFIC CONTROL

G1-9.1 GENERAL DESCRIPTION OF OPERATION

The master traffic control and frame control circuits govern the traffic between connectors and markers during periods of heavy load or, more particularly, whenever requests for markers overlap. When several connectors with several calls each are requesting markers, the most equitable service is given by serving one call out of each waiting connector before serving a second call from any connector. By this means, the connectors with slow-start circuits are not blocked by connectors with faster-start circuits and one connector with several calls backed up cannot block other connectors for an unduly long time.

This process of locking out connectors once served is called "gating" which is the major function of the master traffic control, frame control, and connector control circuits. When a connector is prevented by its control circuit from obtaining a marker, the connector is said to be "gated", and conversely, when it is free to obtain a marker it is said to be "ungated."

The TC and TC1 relays in the connector control circuit, controlling marker start STA and STB leads, determines the gating. When these relays are operated, the connector is prevented from obtaining a marker, and when they are released, the connector can seize a marker.

With dial tone marker operation a short-cycle gate traffic control is used with line link marker connectors and a long-cycle gate traffic control is used with originating and incoming register marker connectors.

Duplicate tube timing circuits are provided and their function is to ungate the connectors in case of trouble and to give a major alarm. One of these circuits is associated with the STA lead and one with the STB lead. The ALA and ALB relays which are operated by the timers are held under control of the MC-AR key in the master test frame. The circuits for ungating the connectors are also under control of keys on the master test frame.

G1-9.2 CONTROL OF TRAFFIC THROUGH INCOMING REGISTER MARKER CONNECTORS (SFD-G140,G141, AND G142)

G1-9.2.1 Circuit Normal (SFD-G142)

When all associated connectors are idle, relays TCA1 and TCB1 in master traffic control circuit are operated and all other relays are nonoperated. The two timing circuits are prevented from functioning by TCA1 and TCB1. Any trouble which would cause relays TMA, TMB, CWA or CWB to operate when the connectors are not in use, will bring in a major alarm.

G1-9.2.2 Single Request for a Marker - No Gating (SFD-G142)

A single connection to a marker which is completed and released before a second request is initiated does not involve gating. In the connector, the control circuit will shift its start lead preference after its use so that a succeeding call will prefer a different marker.

The TM relay in the preference control circuit, operating in response to a request for a marker by an incoming register closes ground to the TCA and TCB leads, and either the CWA or CWB lead (SFD-G142). The CWA or CWB lead is determined by connector control Z relay which also determines whether the STA or STB lead will be used. When Z is normal, the STA and CWA leads are closed, and when Z is operated the STB and CWB leads are closed. The TM also connects the IM relay in the preference control circuit to the IM lead.

If a call is waiting to be served, the TCA and TCB relays operate and then lock to the TCA and TCB leads. The SRA and SRB relays operate and open the TCA and TCB operating path. When the TCA and TCB relays operate, the TCA1 and TCB1 relays release.

With the Z relay normal, CWA is operated. Therefore TMA timer starts to time and the TMB timer is stopped by battery being closed to the control anode through TCB1 contacts. The TMA and TMB relays will be normal if markers are available. The IM relay in the master traffic control circuit also operates and applies ground on IM lead to the preference control circuit, with relay TM operated. The IM relay in the preference control circuit operates and permits transfer timing in that circuit to start (SFD-G210).

The connector multicontact relays operate as a result of STA lead closure to the marker preference relay. The TC and TC1 relays in the preference control operate and open the circuit for the TCA and TCB relays. The TCA and TCB relays release and prevent the operation of the frame control relays FC and FC1. The CWA also releases and TCA1 and TCB1 relays operate to stop timing in the master traffic control circuit. The IM relay in the master traffic control releases to stop the transfer timing in the preference control circuit. The SRA and SRB relays release and the circuit is normal.

If relay Z had been operated, then CWB relay would have been operated on marker request. The TMB timer would have started timing and the TMB timer would have been stopped. Also, start lead STB would have been used on marker seizure.

G1-9.2.3 Overlapping Requests for Marker - Gating

If other requests are being made for markers, other connector control circuit TM relays will be operated and the TCA and TCB relays will remain locked. Since some connectors will be using the STA and some the STB leads, both relays CWA and CWB will be operated and both timers will be timing. As the available completing markers are seized by the connectors, the TC and TC1 relays are operated in those connectors and open their start leads. If other request for markers are being made, the timers will continue timing due to relays CWA and CWB remaining operated and relays TCA and TCB will remain locked. With the TCA and TCB relays operated, frame control relays FC and FC1 operate in all connector frames having any one pair of TC and TC1 relays operated, in turn locking all TC and TC1 relays in those frames. Those connectors are gated, that is, they are prevented from obtaining a marker, since their marker start leads are opened by the TC and TC1 relays. They will remain gated until the TCA and TCB relays release.

The SRA and SRB relays are released. These relays are slow to release to prevent reclosing the TCA and TCB lead until all FC, FC1, TC, TC1 relays are released, since another request during this ungating period could prevent proper release. This interval also allows the last marker connected to finish its work and release in order to prevent gating that connector for another gating cycle.

If the all-markers-busy condition is encountered during the gating cycle, the TMA and TMB relays will operate from the all-markers-busy circuit. The IM relay will release which in turn will release the IM relays in any preference control preventing them from making an ineffectual transfer of the start circuit.

SECTION G, PART 2

COMPLETING MARKER SEIZURE

Index

		PAGE
G2	COMPLETING MARKER SEIZURE	G2-2
G2-1	SEIZURE AND INPUT TO COMPLETING MARKER	G2-2
G2-1.1	MARKER CONNECTOR RELAY CHAIN CIRCUITS	G2-2
G2-1.2	MARKER CONNECTOR BUSY (CB-) RELAY CHAIN	G2-2
G2-1.3	MARKER START (MS-) OR PREFERENCE RELAY OPERATE CHAIN	G2-2
G2-1.4	MS- RELAY WORK CHAIN	G2-3
G2-1.5	W AND Z RELAY CONTROL FOR TRANSFERRING START LEADS	G2-4
G2-2	TIMING FUNCTIONS ON THE PREFERENCE CONTROL CIRCUIT	G2-5
G2-2.1	TRANSFER START TIMER	G2-5
G2-2.2	OVERALL TIMER	G2-6
G2-3	INFORMATION FROM THE IRMC TO THE CM	G2-6
G2-3.1	CALLED NUMBER INPUT FROM THE IRMC TO CM	G2-8
G2-3.2	TYPES OF TRANSLATORS	G2-8
G2-3.2.1	LT Local Translator	G2-8
G2-3.2.2	Five Digit (FVD) Translator	G2-8
G2-3.2.3	Two Digit (2DT) Translator	G2-8
G2-4	DIRECT SIGNALS USED IN CONJUNCTION WITH TRANSLATORS	G2-9
G2-4.1	REORDER (RO)	G2-9
G2-4.2	LINK RELEASE (LR)	G2-9
G2-4.3	DOUBLE CONNECTION CHECK (DCK)	G2-9
G2-4.4	FIRST OR SECOND TRIAL	G2-9
G2-4.5	TRUNK LINK FRAME IDENTIFICATION	G2-9
G2-4.6	TRUNK NUMBER REGISTRATION IN MARKER	G2-9
G2-4.7	TANDEM CLASS	G2-10
G2-5	OPERATION OF THE CKG1,2 GC, LLC1,2, ONX, TLC1,2, AND BX RELAYS	G2-10
G2-6	TEST CALL DIGIT CONTROL	G2-11

G2 COMPLETING MARKER SEIZURE

After the IR receives all digits and the incoming tandem trunk has been prepared to assume control of the connection, the IR establishes a connection to the CM through the IRMC and passes information to the CM that is used to complete the call.

G2-1 SEIZURE AND INPUT TO COMPLETING MARKER

Upon operation of a TC2 relay in the incoming register and RB relay in the IRMC (SFD-G204), start battery is applied to activate a marker start STA lead or a marker start STB lead to start seizure of a completing marker. As will be seen later, the Z relay is operated and released on alternate calls so that the STA and STB start leads are alternately activated on successive calls. Each register is given preference to one completing marker for an MSA start and to another for an MSB start by cross-connecting MSA and MSB punchings on SFD-G204 to appropriate MS- punchings on SFD-G205.

G2-1.1 MARKER CONNECTOR RELAY CHAIN CIRCUITS (SFD-G205)

Three chain circuits are used in selecting a completing marker and closing the connector relays between the register and the marker selected. The following are typical descriptions of chains also used in other connectors.

G2-1.2 MARKER CONNECTOR BUSY (CB-) RELAY CHAIN

An operated CB- relay indicates that the associated marker is busy to the connector. A CB- relay operated for a preferred marker advances the start lead to the next preferred marker. If the CB- relay for that marker is also operated, the start lead is advanced to the next preferred marker, etc.

G2-1.3 MARKER START (MS-) OR PREFERENCE RELAY OPERATE CHAIN

In periods of very light traffic (and assuming no markers busy) MS- relay operation is straightforward. A start signal from an incoming register operates the MS- relay associated with the MS- terminal to which the start lead is cross-connected.

In periods of heavy traffic one or more markers may be busy and two or more incoming registers may initiate marker requests either simultaneously or in rapid succession.

Assume that the first and last incoming registers (SFD-G204,G205) initiate simultaneous marker requests. Also assume that both start

leads are connected to MSO (that is both prefer marker 0). The MSO relay associated with each of the two registers will operate through the MSK cross-connection to ground in the marker. An early make contact on the MSO relay for the first register will provide locking ground for that MSO relay before the break contact on the MSO relay for the last register opens the MSK ground. Thus, both relays will operate and lock.

If, however, the last register initiated a request for a marker slightly ahead of the first register, the MSO relay for the first register could not operate. On the other hand, if the first register initiated a marker request first, a subsequent request by the last register could operate the MSO relay for that frame.

G2-1.4 MS- RELAY WORK CHAIN

Since it is possible to operate two or more MS- relays at the same time, the work chain determines which MS- relay does the work. Ground for the work chain initiates in the marker at the MAK cross-connection. It should be noted that the work chain proceeds through contacts of each MSO relay in a reverse direction to the preference MSK chain. Contacts on the MSO relay for the first incoming register are, therefore, enabled to operate connector relays MA- through ME- whether or not any other MSO relay is operated.

Upon operation of the incoming register marker connector relays (MA- through ME-), the MCB- relays of the selected marker are operated over the MB lead (SFD-G206). The MCB- relays operate CBO relays in every connector having access to that marker (SFD-G206). It should be noted that an operated MA- connector relay contact bridges the break contact of the CBO relay in the start path so that the operated MSO relay is not released when the associated CBO relay operates.

If two or more MSO relays had operated for different incoming registers, the start lead for each of those which failed to get a marker would be advanced to the next preferred marker by operated CBO relays. If, however, no other marker was available no new MS- relay would operate until some marker became available at which time, one or more MS- relays for that marker would operate. This would continue until all registers had been served.

During periods of heavy traffic when all completing markers become busy, a traffic control circuit gates requests by incoming registers for CMs as described in the SFD-D1 section so that all registers requesting service are served once before any register is served a second time.

Relay MS- in operating releases the marker connector check relays MAK, MCK, and MSK (SFD-G205). The release of any one of these relays operates relay TM (SFD-G206) which starts marker timing.

G2-1.5 W AND Z RELAY CONTROL FOR TRANSFERRING START LEADS (SFD-G204)

If only one start lead was provided, then, under light traffic conditions, a particular connector might seize the same marker for every usage. If this marker is in trouble, all calls from that register might be blocked. To prevent this and also to reduce the adverse effects of other circuit failures, two start leads are provided in each marker connector. By alternating the use of these start leads, two markers serve alternately as first choice markers, thereby providing more even wear on the marker connectors. This transfer is accomplished with a W and Z relay combination. The operation and release of relay MK provides the necessary transfer.

In the following description, assume that relay Transfer Start (TRS) is normal. The W and Z relay combination (SFD-G204) operates as follows:

(a) FIRST CONNECTOR USAGE

Marker seizure - Assume that relays MA- through ME- of the incoming register marker connector and W and Z of the preference control circuit are normal. Lead STA has continuity through the break contact of relay Z and lead STB is open. A marker is seized by operation of relay MS- via the MSA to MS cross-connection. Relay MS- causes the operation of relays MA- through ME-. Relay MA- operates relay MK in the preference control circuit (SFD-G204), which in turn operates relay W which locks.

Connector release - When the connector releases, release of the MA- relay releases relay MK which causes the Z relay to operate through the operated W. Relay Z locks operated from the ground of relay W which remains operated but the locking ground for W is now through the operated Z of the released MK. The operation of relay Z opens start lead STA and closes STB making it available for future usage.

(b) SECOND CONNECTOR USAGE

Marker seizure - At this time relays MA- through ME- are normal. Relays W and Z are operated. A marker is seized by the operation of relay MS- via the MSB to the MS- cross-connection. Relay MS- causes relays MA- through ME- to operate. The operation of relay MK, this time, opens the locking path of the W allowing it to release.

Connector release - The release of relay MK when the connector releases removes the Z relay holding ground, allow- it to release. Relay W remains released. The release of relay Z opens lead STB and closes lead STA making it available for the next connector usage. For subsequent usages the actions described above repeat.

G2-2 TIMING FUNCTIONS IN THE PREFERENCE CONTROL CIRCUIT

Timing circuits in the preference control circuit, control marker seizure and once the marker is seized, time its overall function. These timing circuits are discussed below.

G2-2.1 TRANSFER START TIMER (SFD-G210)

The transfer start timer allows an interval of 0.6 to 1.25 seconds for the IRMC to connect to a CM (unless all CMs are busy). If the connection is not established in this time, the preference control circuit transfers the start leads and gives a TRS signal to the CM to cause a trouble record to be taken showing that there is a transfer start condition.

The operation of the TC2 relay in the IR operates the TM relay (SFD-G210). The TM relay operates the TM1 and also closes through the IM lead from the master traffic control to operate the IM relay. The IM lead will normally be grounded unless all CMs are busy, in which case operation of the IM relay is delayed until a CM becomes idle. The IM relay starts the TRS timer.

The TRS timer continues to time until the connector relays MA- through ME- operate. To check that the connector relays have operated, the MA- relay connects ground to the CKG lead to operate CKG1,2 relays. The CKG2 relay connects ground to the MTFC as a check that the connector relays operate. The MC- relay grounds the TC and TC1 leads to operate the TC and TC1 relays in the preference control circuit. The operated TC and TC1 relays in the PC opens the path to the IM relay (SFD-G210) which stops and recycles the TRS timer.

If a marker is not seized in approximately 1.0 second, (providing markers are available as indicated by ground on the IM lead), the TRS tube will fire and operate the TRS relay. The TRS relay opens the start lead in use, closes the alternate one (SFD-G204), releases the TM relay in the preference control, and holds the TM1 relay operated (SFD-G210). The TM relay is released to open the signal leads CWA and TCA (SFD-G210) to the traffic control circuit to prevent its timing out because of a marker connector trouble. The TM relay also releases the IM relay to recycle the timer (SFD-G210). The TM1 relay is held operated to continue the overall timing before a marker is seized. The TRS relay locks operated through the TM1 relay. When a marker is obtained over the new start lead, the TM1 relay releases upon operation of the MK relay. The TRS relay remains operated over its locking contacts under control of the MK relay. The TRS relay transmits to the marker the fact that the transfer has taken place. This information is passed over the TRS lead. The marker causes a trouble record to be taken showing a TRS punch and indicating the IR which encountered the TRS failure. Upon release of the marker, the MK relay, in releasing, will release the TRS relay.

G2-2.2 OVERALL TIMER (SFD-G207)

An overall timing circuit is provided which sounds the major alarm if an IR calling for a marker has not been connected to one within 4.8 to 10 seconds. It functions as follows: Upon the start of a call, operation of a TC2 relay operates the TM relay in the Preference Control circuit (SFD-G210) concurrently with battery connection to the start leads for marker seizure. The TM relay operates the TM1 relay which starts the overall TM timer (SFD-G207).

For normal operation, a marker is seized before the timing interval has elapsed. This is indicated by the operation of the MK relay (SFD-G207)from the operated marker multicontact connector relays in the incoming register marker connector circuit. The MK relay releases the TM and TM1 relays. During the releasing time of the TM and TM1 relays, the TM tube timer circuit is recycled by discharging the A capacitor through the C resistance. The TM1 relay normal with the MK relay operated restarts the A capacitor charging circuit to time the release by the marker. If the marker releases the connector within the timing interval, the TM tube will not fire. However, should the marker exceed this time because of some trouble condition or should the marker connector relays remain operated due to a trouble, the TM tube will fire, operating the CA relay which brings in the major alarm and causes the IRMC- lamp at the JLK to remain lighted. This lamp normally flashes on each time the MK relay operates as an in use indication for the IRMC. When it remains steadily lighted, it serves as an IRMC alarm indication.

The MK relay releases at the end of the call upon release of the incoming register marker connector circuit multicontact relays, and discharges the A capacitor to recycle the TM timer for the next call.

G2-3 INFORMATION FROM THE IRMC TO THE CM (SFD-G202)

When the IRMC is operated, it closes through a large group of leads between the register and the marker in order that the register can transmit many pieces of information at the same time. The information transmitted through the IRMC is shown in Table A on the following page.

TABLE A

Information transmitted through the incoming register marker connector

A2/5, L2/5, M7	Called Number
LT, 2DT, FVD	Type of Code translator required in marker.
TAN	Tandem class of trunk used and all digits of the office code and no screening or restrictions apply.
TAN-1-4	Tandem Class of Trunk Used and (a) Five Digit (FVD) tandem calls are received and the trunks transmit only one digit of two or three digit home area office codes and/or screening or restrictions apply. (b) Six digit (BX) tandem calls are received and the trunks transmit two digits of three digit home area office codes and/or screening or restrictions apply. (c) Tandem calls are received and the trunks transmit all the digits of the office code and/or screening or restrictions apply.
HT2/5, TT2/5, UT2/5	Hundreds, tens, and units number of incoming tandem trunk used for translation to line link appearance.
TRK, TR2, TRS	First and second trial, and start lead transfer signals.
RO, LR, DCK	Trouble and Check Signals from the Register.
CKG, TM, MB	Marker Seizure from Register.
MRL, BT, TRL	Release Signals to Register for Normal, Busy, and Trouble Release.
ECN, OCN	Even or Odd connector in IRMC used in connection.

G2-3.1 CALLED NUMBER INPUT FROM THE IRMC TO THE CM, AC2/5-CC2/5, D2/5-L2/5, M7 (SFD-G212)

The called number may contain from 1 to 11 digits, A-L. Each digit is received on a 2-out-of-5 code basis. There are various numbering plans that can be used, but in general the numbers consist of the following:

(a) 4 numerical digits

(b) 1, 2, or 3 digit office code, plus 4 numerical digits.

(c) 3 digit area code, 3 digit office code and 4 numerical digits.

On a tandem call, the code digits plus the type of translation selects a code point that determines the marker routing.

G2-3.2 TYPES OF TRANSLATORS

The marker provides several types of translators to handle the various offices. The type of translator to be used is always indicated to the CM by the register. The various translator indications used in tandem type calls are:

(a) LT - Local Translator

(b) FVD - Five Digit Translator

(c) 2DT - Two Digit Translator

In this section of the SCD the local translation, the FVD translation and the 2DT translation will be discussed.

G2-3.2.1 LT, Local Translator

This indication requests the CM to use the translator provided for the respective tandem class to transmit the full home area office codes.

G2-3.2.2 FVD, Five Digit, Translator

This indication requests the CM to use the translator provided for the respective tandem class to transmit 1 digit of 2 and 3 digit home area office codes.

G2-3.2.3 2DT, Two Digit Translator

This indication requests the CM to use the translator provided for the respective tandem class to transmit 2 digits of 3 digit home area office codes (BX codes).

G2-4 DIRECT SIGNALS USED IN CONJUNCTION WITH TRANSLATORS

G2-4.1 REORDER (RO)

This condition is caused by a register timeout or register detection of a dialing error.

G2-4.2 LINK RELEASE (LR)

A link release trouble is due to failure of the register to receive information from the incoming register link.

G2-4.3 DOUBLE CONNECTION CHECK (DCK) (SFD-G118)

With the double connection check is operated in the CM, it indicates that the LR indication was not caused by a double connection at the IRL. The DCK punch indication will be shown when a trouble record is taken in conjunction with the LR and the trouble is not caused by a double connection.

G2-4.4 FIRST OR SECOND TRIAL (SFD-G210)

Ground on the TRK lead indicates to the CM a first attempt to complete the call. If the CM fails to complete the call and a second attempt is possible, the CM grounds the Trouble Release (TRL) lead to the connector which causes the connector to shift start leads and make a second attempt to complete the call.

On the second attempt the Second Trial (TR2) lead is grounded and the second trial relay in the CM operates when the marker is seized. The TR2 relay causes the CM to shift preference circuits, to cancel line tests, and causes a BT or trouble release signal to be sent to the register in case trouble prevents completion of the call.

G2-4.5 TRUNK LINK FRAME IDENTIFICATION (SFD-G211)

The trunk link frame number is in two parts, the frame tens number and the frame units number. The tens number is on 1-out-of-3 basis and is designated FGO-2. Frame units is 2-out-of-5 and is designated TFO,1,2,4,7. This information originates from cross-connects in the IRL and passed to the CM from the IR.

G2-4.6 TRUNK NUMBER REGISTRATION IN MARKER

When a call is switched through the office, Tandem Outgoing (TOG), the call is handled similar to a SOG call in that a route relay is operated and an outgoing trunk is selected. However, the line link appearance necessary to complete the channel and establish the network connection

is received from the incoming register as a 3-digit number assigned to an incoming tandem trunk to be translated by the NG and recorded on the FTT-, FUT-, VGT-, HGT-, and VFT relays in the CM to control selection of the line link (SFD-G510).

This 3-digit number is determined by the assignment of the tandem trunk appearance in the IRL and cross-connections in the IR. The Trunk Number (TRN) relay operates in the CM (SFD-G209) instead of the N1-N4 relays to cut through the HT- leads to operate the HN- relay to register the hundreds digit (SFD-G214-G216). The operated TRN relay also extends the TT- leads to operate the T- relays for the tens digit (SFD-G215-G217) and the UT- leads for registration of the units number (SFD-G218). The marker may be arranged for a maximum of 2000 trunk numbers. Two number groups are provided for translating each group of 1000 trunk numbers in order to prevent troubles from blocking tandem or toll calls.

G2-4.7 TANDEM CLASS (SFD-G209)

When a TAN class signal is received from the IR, the Trunk Class Check (TCCK) relay operates. The operation of the TCCK and the TOG1, TOG2 relays indicate that the call is to be switched through the office. The operation of the TOG1, TOG2 relays causes the Forward Linkage Ground (FLG) relay to operate to set up the linkage on an incoming tandem trunk connection and prepares the marker to seize the number group.

G2-5 OPERATION OF THE CKG1,2 GC, GCA, LLC1,2, ONX, TLC1,2, AND BX RELAYS

To provide a large number of off-normal grounds and battery potentials to the marker circuit and to interconnect certain functional units, the CKG1,2; LLC1,2; and TLC1,2 relays will be operated.

The operation of the IRMC MA- through ME- relays will extend ground to the CKG lead and will operate the CKG1,2,4,5,6 relays in the marker (SFD-G210). The CKG- relays provide off-normal grounds.

The CKG1 relay will operate the BX and ONX relays (SFD-G209). The BX relay provides bias for some of the cross-detecting relays, while the ONX relay provides means for testing for crosses on the select magnet leads.

The operation of the CKG2 relay will operate the TLC1,2 relays (SFD-G209). The TLC1,2 relays provide battery potential for operating the trunk link connector cut-through relays and other miscellaneous off-normal ground and battery functions.

The operation of the CKG4 relay will operate LLC1,2 relays (SFD-G209). The LLC1,2 relays provide battery potential for seizing the line link frame and operating the line link connector cut-through relays. The LLC1,2 relays also provide other miscellaneous grounds and batteries.

The operation of the LLC1 relay will operate the GC or, if provided, GCA relays which provide junctor group control functions (SFD-D617).

G2-6 TEST CALL DIGIT CONTROL (SFD-G219, G220)

On all trunk test classes, when the marker connector relays are operated, the Terminating Test Line (TTL) relay operates. The TTL relay operated, connects the winding of the KA, KB, and KC relays to ground through contacts of any operated A(0-9), B(0-9), and C(0-9) keys or switches (SFD-G212), respectively, and also extends ground to make effective the TTL and Busy Back (BB) keys (SFD-G219,G220).

The TTL relay operates the K relay which operates the K1 relay (SFD-G219). The K1 is slow-operating to allow the slowest K(A-L) relay to operate before continuing the function of the circuit. The operated K1 relay provides ground for the K(A-L) relay contact chain. The last operated K(A-L) relay extends the ground to lead 7 of the next higher lettered digit as an indication to the marker that no further digits are to be expected.

Although any called number can be set up on the A(0-9) through L(0-9) keys or switches, there are certain test numbers which will be used for the majority of tests. An area may have office codes of variable numbers of code digits which means that the numerical digits following a 1-digit office code would have to be set on B, C, D, and E keys while the numerical digits following a 3-digit office code would have to be on the D, E, F, and G keys.

The TTL key is used to automatically prime the marker with the line number of the terminating test line to the trunk test circuit on IAO and ITNP classes of test which operates the TTL1, TTL3, TTL5, or TTL8 relay depending on the type of terminating test line required.

The TTL key is used to automatically prime the marker with the line number common in the area for the incoming trunk terminating test line circuit on OGT, MISC, and ITDO classes of test which operate the TTL1, TTL2, or TTL7 relay depending on the type of terminating test line required.

The BB key is used to prime the marker with the line number common in the area for a permanently busy line on IAO, ITNP, OGT, MISC, and ITDO classes of test which operates the BB relay.

To use the TTL or BB keys, the office code for the route which includes the trunk to be tested is set up on the called number keys.

A 1-digit code is set up on the A(0-9) key or switch.

A 2-digit code is set up on the A(0-9) and B(0-9) keys or switch.

A 3-digit code is set up on the A(0-9), B(0-9), and C(0-9) keys or switch.

If there is no office code, no called number keys are operated.

When the TTL relay operates, the KA relay operates if any A(0-9) key or switch is operated, the KB relay operates if any B(0-9) key or switch is operated, and the KC relay operates if any C(0-9) key or switch is operated (SFD-G220).

Operation of any TTL- or BB- relay operates the K2 relay which is sufficiently slow-operate to allow time for the KA, KB, and KC relays to operate (if they are going to). The K2 grounds a lead which feeds through transfer contacts of the KA, KB, and KC relays to operate the NA and NA1, number connector, relays (if KA, KB, and KC relays are all normal), to operate NB and NB1 relays (if only KA is operated and KB and KC normal), to operate NC and NC1 relays if only KA and KB are operated and KC normal, and to operate ND and ND1 if KA, KB, and KC relays are operated.

The NA and NA1 relays close the thousands cross-connections of the TTL- and BB- relays to the A leads, hundreds to the B 2/5 leads, tens to the C 2/5 leads, and units to the D 2/5 leads, and grounds the E7 lead. The NB and NB1 relays shift the TH-, H-, T, and U- cross-connections to the B, C, D, and E 2/5 leads, and grounds the F7 lead. The NC and NC1 relays shift the TH-, H-, T-, and U- cross-connects to the C, D, E and F 2/5 leads, and grounds the G7 lead. The ND and ND1 relays shift the TH, H, T, and U cross-connections to the D, E, F, and G 2/5 leads and ground the H7 lead.

SECTION G, PART 3

SENDER SELECTION AND CONTROL

Index

		PAGE
G3	SENDER SELECTION AND CONTROL TANDEM CALL	G3-2

G3 SENDER SELECTION AND CONTROL TANDEM CALL

A No. 5 crossbar office is required to supply information to a distant terminating office when the call is to be switched through the connecting or tandem office. Senders are used to store the call information received from the markers. The senders may be required to convert information to multifrequency signals or pulse trains (a string of pulses) that can be used by the distant terminating office. The connecting offices may be of various types and each office type may require a different sender type to work with that office. Senders are arranged into sender groups with a maximum of 10 senders in a group. The senders in a sender group have the same type of pulsing. There can be a maximum of 12 sender groups in an office (marker group). Each sender group is subdivided into sender subgroup A and sender subgroup B, with a maximum of 5 senders in a subgroup.

On a tandem call the selection of a sender is almost identical to the same operations performed on a regular outgoing call requiring the use of a sender. See SFD and SCD section C2 for detailed description of sender selection.

SECTION G, PART 4

CONNECTION TO A TRUNK LINK FRAME AND TRUNK

Index

		PAGE
G4	CONNECTION TO A TRUNK LINK FRAME AND OGT ARRANGED FOR TANDEM	G4-2

G4 CONNECTION TO A TRUNK LINK FRAME AND OGT ARRANGED FOR TANDEM

When a completing marker has been seized and has received input information through the IRMC directing the marker to establish a tandem class of call (TOG), it proceeds to select a trunk link having an idle trunk of the correct type. The selection of the outgoing trunk arranged for tandem operation is almost identical to the selection of an outgoing trunk on a regular call. See SFD and SCD C3 for detailed description of connection to a trunk link and selection of proper type of trunk.

SECTION G, PART 5

CONNECTION TO THE NUMBER GROUP FRAME

Index

		PAGE
G5	CONNECTION TO NUMBER GROUP	G5-2
G5-1	CAPACITY OF NUMBER GROUP	G5-2
G5-2	NUMBER GROUP SEIZURE	G5-2
G5-3	OFF-NORMAL CONTROL	G5-3
G5-4	PREFERENCE CONTROL CIRCUIT	G5-3
G5-4.1	MP RELAY OPERATE CHAIN	G5-3
G5-4.2	MP RELAY WORK CHAIN	G5-4
G5-4.3	EMERGENCY TRANSFER	G5-4
G5-4.4	MANUAL TRANSFER	G5-5
G5-5	NUMBER GROUP TRANSLATION	G5-5
G5-5.1	REGISTRATION OF HUNDREDS DIGIT	G5-6
G5-5.2	REGISTRATION OF TENS DIGIT	G5-6
G5-5.3	REGISTRATION OF UNITS DIGIT	G5-6
G5-5.4	TRANSLATED INFORMATION PASSED TO COMPLETING MARKER	G5-6
G5-6	INTERCEPT TREATMENT	G5-7

G5 CONNECTION TO A NUMBER GROUP

In a No. 5 crossbar office, there is no permanent or prearranged association of trunk numbers with switch positions on the line link frames. A marker upon receiving the 3-digit trunk number of the incoming tandem trunk must determine which one of the switch verticals in the office is associated with that particular trunk number so that a connection may be established. The marker obtains this information from one of two number group frames containing this trunk number for the necessary translation.

G5-1 CAPACITY OF NUMBER GROUP

The No. 5 crossbar marker group is equipped for a maximum of 40,000 numbers (directory and trunk) arranged for 6 number series as follows:

Number Series Group A	Number Series Group B
No. Series 0	No. Series 1
No. Series 2	No. Series 3
No. Series 4	No. Series 5

Each 1000 directory numbers/trunk numbers comprise a number group. A number group can have both directory numbers and trunk numbers assigned or only trunk numbers. A marker group can accommodate 40 such number groups or a total of 40,000 directory numbers including trunk numbers. Number groups are provided to fill the needs of the respective number series and should be considered as independent of number series groups. The frames are numbered as they are added from 00 through 39.

G5-2 NUMBER GROUP SEIZURE (SFD-G504)

On a local completing call, the number series start relays are used to direct the completing marker to a start lead to seize a number group frame. On TOG calls the TFK2 and SNG2 relays operate with the Trunk Number (TRN) to direct the marker to either an even trunk number group or an odd trunk number group. The selection of what number group to be used is determined by the STA and STB cross-connection terminals and the ECN/OCN connector used by the IRMC. For tandem trunks, the translation is the same from both number groups because only one line link appearance is provided.

When the TFK2 relay (SFD D304), the SNG 2 (SFD D408), and the TRN (SFD G209) relays operate, the Marker Preference (MP-) relay in the number group preference control and make-busy circuit operates (SFD-G505). This seizes the number group connector frames, which connects the marker to the NG by operating the connector multicontact relays. The connection to the NG by the marker is checked by the operation of the NGK and NGK1 relays and their associated punches.

G5-3 OFF-NORMAL CONTROL

When the Forward Linkage Ground (FLG) relay and translation relays operate the completing marker operates relays that will control information to and from the number group.

The FLG operates the SNG1, 2 relays. These relays control the operation of the MCB-MCE relays in the NGC (SFD-G504) and in conjunction with the HN-, TN-, and U- relays will operate translation relays in the number group (SFD-G506). The translation relays cause the operation of the Line Link Idle (LLI) relay, the NGC (number group control) relay and the Units Cut-In (UC) relay to further control the translation of the three digit trunk number to a line location.

G5-4 PREFERENCE CONTROL CIRCUIT (SFD-G505)

The preference control circuit associated with the number group connectors provides two preference relays MP- and E- per marker for each number group connector.

There is means for detecting trouble associated with both the MP- and E- relays and for automatically switching from one to the other in the event of detected trouble. The MP- relays are interconnected by three chain circuits which enable connection of one marker at a time to a number group frame. Similar independent chains interconnect the E- relays. While the following description is for MP- relays, if applies equally to the E- relays.

G5-4.1 MP- RELAY OPERATE CHAIN

In periods of very light traffic (assuming only one marker at a time applies start battery to bid for seizure of a NG), MP- relay operation is straightforward. A start signal battery from a marker is applied to the associated MP- relay winding which is connected through the MP- operate chain to ground at the winding of the first relay in the operate chain.

In periods of heavy traffic, two or more markers may initiate requests either simultaneously or in rapid succession.

Assume that the first and the last markers in the preference chain initiate simultaneous request for connection to the same NG. Both MP- relays will operate and lock. If, however, the last marker has initiated a request slightly before the first marker, the MP- relay for the first marker could not have operated because ground for its winding would have been opened by the operate chain at the MP- relay for the last marker. On the other hand, if the first marker initiated a bid first, any other marker ahead of it in the operate chain could subsequently operate its MP- relay.

G5-4.2 MP- RELAY WORK CHAIN (SFD-G505)

Since it is possible to operate two or more MP- relays at the same time, a work chain determines which MP- relay does the work. The work chain progresses through contacts of the MP- relays in the opposite direction to the operate chain, starting with ground at contacts of the MP- relay for the first marker. If the MP- relay for the first marker is operated, the work chain ground will operate the number group connector, MCA, relay whether or not other MP- relays are operated. The MCA relay operates the MCB-MCE relays by closing through battery supplied by the marker.

When the marker which has seized the NG has finished its job and opened the start lead to the preference control, its MP-relay is released. If there are any other operated MP- relays, the next MP- relay in the work chain which is operated now functions as just described. This continues until all operated MP- relays have been served.

G5-4.3 EMERGENCY TRANSFER (SFD-G505)

Two sets of preference relays MP- and E- are provided in the preference control either of which can perform the preference job while the other serves as a standby. The CH relay provides trouble detection on the active set of preference relays by monitoring the operate chain and one of the work chains. Assume that the TR key and TR relay are normal so that the MP- relays are active. When all MP- relays are normal, ground through all the break contacts of the operate chain is connected to one side of the CH relay winding. The ground through all the break contacts of the work chain which operated connector relays is connected to the other. The CH relay cannot operate with ground on both sides of its winding. When one or more of the MP- relays operate, both preference chains are opened to remove ground from both sides of the CH relay winding leaving resistance battery connected to both sides of the winding. Again the relay cannot operate. If, however, all break contacts

of either chain do not conduct, or if a wire is broken when the MP- relays are all normal, one side of the CH relay winding will have ground and the other resistance battery which will operate the CH relay. Also, if any of the break contacts fail to open or if there is a false ground on either chain when one or more MP- relays operate, the CH relay will again have resistance battery on one side of its winding and ground on the other and will operate.

If the CH relay operates, even momentarily, the TR relay operates and locks. The TR relay operates TR- relays which transfer the ST-, TMB, and MC leads from MP- relays to E- relays. The TR relay also brings in a minor alarm and lights a CH lamp.*

The alarm can be restored by momentarily operating the AR key located at the frame or can be restored remotely via the alarm sending circuit. Release of the alarm also restores operation to the MP- chain if the TR key is normal or to the E- chain if the TR key is operated.

G5-4.4 MANUAL TRANSFER

By operating the TR key, located at the connector control frame, preference control can be manually transferred from the MP- to the E- relays. The TR key operates the TR- relays which remain operated to accomplish the transfer as described previously. The TR key also connects the CH relay to chains of the E- relays. If the CH relay operates, it operates the TR relay which locks and releases the TR- relays to transfer preference back to the MP- relays.

G5-5 NUMBER GROUP TRANSLATION

After seizing the number group, the marker connects -48 volts through resistance lamps, to the hundreds, tens, and units leads, as determined by the operated HN-, TN-, and U- relays, to select one terminal from the 1000 sets of number terminals. The number group translates the trunk number, represented by this one terminal, into a line location and passes this information to the marker.

* Although the CH lamp is shown as part of the number group connector circuit, it and the alarm release key are located on a frame designated as "number group connector control."

G5-5.1 REGISTRATION OF HUNDREDS DIGIT (SFD-G506)

An HB 0-9 relay in the NG is associated with the hundreds digit of the called number. Battery is extended to the NG over the HB 0-9 leads associated with the HN 2/5 relays to operate a HB 0-9 relay in the NG.

G5-5.2 REGISTRATION OF TENS DIGIT (SFD-G506)

A TB 00-99 relay in the NG (associated with the tens and hundreds digit of the trunk number) is operated to indicate the 100 groups of ten trunk numbers in which the trunk number is located. The PN, TN, EN or PTN relay closes battery to the NG over the one TB 0-9 lead associated with the operated T 2/5 relays. The TB- lead is extended in the NG through the HB-relay contacts to operate the one TB 00-99 relay associated with the tens digit and hundreds digits of the trunk number. The marker TBW (tens block wetting) relay, operates in series with the NG TB- relay and checks that the operate path has been completed.

G5-5.3 REGISTRATION OF UNITS DIGIT (SFD-G507)

A U 0-9 relay in the NG is operated when the NGC relays close the U 0-9 leads from the marker to the NG. Battery is closed through the operated U 2/5 relays, and through the UC relay, in the marker to one of the U 0-9 leads to the NG. The operation of the NG U- relay extends ground over the UK lead to the marker, operating the Units Check (UK) relay, which checks that the NG units relay has operated.

G5-5.4 TRANSLATED INFORMATION PASSED TO COMPLETING MARKER (SFD-G509)

Each of the 1000 numbers in a NG has three terminals designated L, G, and F. Each of the 1000 numbers also has three separate fields of cross-connection terminals. These three fields consist of the LL-, VHG- and the five RFTN terminals 0-4 or TN- cross-connection used for trunk number identification.

The hundreds, tens and units digit transmitted to the NG by the marker determine which set of L, G, and F terminals are connected to battery from the marker over the WL, WG, and WF leads.

The L terminal is cross-connected to an LL- terminal, which extends battery over the FT 0-5 leads and FU 0-9 leads to cause operation of the proper Frame Tens Number (FTN 0-5) relay, and Frame Units Number (FUN 0-9) relay in the marker.

The G terminal is cross-connected to a VHG- terminal, which extends battery over the HG 0-9 leads and VG 0-11 leads to cause operation of the proper Horizontal Group Number (HGN 0-9) relay and Vertical Group Number (VGN 0-11) relay in the marker.

The F terminal is normally cross-connected to one of the RFTN 0-4 terminals for operation with tandem trunk number operation. When the marker places battery on the WF lead, the NG extends this battery back to the CM over one of the VF 0-4 leads to operate a Vertical File Number (VFN) relay in the marker and the TNK lead to operate a Trunk Confirm (TRC) relay and Trunk Number Check (TNK) relay in the CM to tell the marker that a trunk number is involved. Number groups containing trunk numbers and trunk number groups both require the F to RFTN-cross-connection to indicate the trunk number check to the marker. A TB 00-99 to TNA cross-connection will operate the TN- relay to operate in parallel with the TB- relay grounding the TNK lead to the marker. The TB- to TNA- cross-connection is also used for number groups containing both trunk numbers and directory numbers. If the number group is used for tandem trunks only, a ground is connected to the TNK lead to satisfy the marker.

This information is then stored on the corresponding FTT-, FUT-, VGT-, HGT-, VFT-, relays which lock through their associated FTL, FUL, VGL, HGL, VFL, relays located on SFD G510.

To check that the lock relays operate, the Lock Auxiliary (LA) relay operates in the marker (SFD G510) to check that one and only one line location relay has operated, the HTK1, VTK1, and FTK1 relays operate and ground the associated punch (SFD G510).

G5-6 INTERCEPT TREATMENT

The marker connects the calling line to intercept under the following conditions:

(a) A number associated with the line link appearance of a trunk is called.

(b) A blank number is called.

(c) A changed or disconnected number is called.

(d) The physical and theoretical match is not made.

The conditions listed above cause the operation of one of the intercept relays listed below:

(a) BN - This causes the calling line to be connected to a no such number tone trunk or a machine intercept announcement.

(b) RI - This causes the calling line to be connected a regular intercept trunk.

(c) OVC/PMO - This causes the overflow tone ringing condition to be set up on the ringing selection switch. These intercept conditons are described in detail in the SCD-D4 section. Intercept treatment for tandem trunk numbers will be handled by the marker in the same manner in which incoming directory numbers are processed. There are certain limitations in the subscriber and trunk number assignment which must be observed in the number groups used for combined service. Classification of trunk numbers or subscriber numbers will be by tens block. Tens block relays assigned to trunk numbers in the pair of number groups used for combined service must be of the same numerical designation. Trunk numbers cannot be used for subscriber numbers or vice versa. That is; if a trunk number is 123, then in the pair of number groups having trunk numbers, subscriber numbers ending in 120-129 cannot be assigned in these number groups. If a customer calls a trunk number, ground is placed on the TNI punching (SFD G512) and through a desired intercept cross-connection, the marker routes the call to the designated intercept treatment.

SECTION G, PART 6

CONNECTION TO A LINE LINK FRAME

INDEX

		PAGE
G6	CONNECTION TO LINE LINK FRAME CONTAINING TANDEM TRUNK APPEARANCES	G6-2

G6 CONNECTION TO LINE LINK FRAME CONTAINING TANDEM TRUNK APPEARANCES

The Line Link (LL) containing the line location of the incoming tandem trunk is seized to enable the marker control of the desired select and hold magnets. On a tandem call the selection of a LL, and necessary functions to establish a tandem switching connection is almost identical to the same operations performed by a marker on a regular incoming call. See SFD and SCD D5 for detailed description of LL seizure and control.

SECTION G, PART 7

CHANNEL SELECTION AND HOLD MAGNET OPERATION

INDEX

		PAGE
G7	NETWORK CONNECTION FOR TANDEM SWITCHING	G7-1

G7 NETWORK CONNECTION FOR TANDEM SWITCHING

During light traffic conditions, at the completion of hold magnet timing, the marker operates all hold magnets except the line hold magnet and applies the False Cross-Ground (FCG) test to the tip and ring leads before completing the connection. The line hold magnet is operated following the successful completion of the FCG test. The continuity test is made to check that the tip and ring crosspoints of the channels are closed. The Double Connection Test (DCT), relay tests the sleeve conductor associated with the selected channel for false ground. When the DCT relay operates, it indicates that the double connection test is satisfactory, and that there are no false grounds on the sleeve lead. On heavy traffic, all hold magnets are operated at the same time and the FCG and CON tests are canceled. Ground test is also canceled unless Loop Ground Test (LGT), is required.

The operation of the DCT1 relay on TOG calls releases the incoming trunk F relay, which releases the incoming trunk TF relay (SFD-G115, G133). The frame hold magnets are then held operated by the holding ground in the incoming tandem trunk. The marker then checks for the application of this holding ground and for the continuity of the crosspoints which is indicated by the release of the DCT relay. When the DCT releases, the DCT3 operates and releases the OGT relay (SFD G804). The release of the OGT relay releases the TL FA-/FB relay.

The sender and trunk information is checked to insure its proper transmission (SFD C502, C503). Connections between the line location of the incoming tandem trunk and the OGT arranged for tandem are made by closing the line switch and junctor switch crosspoints on the LL, and the trunk and junctor switch crosspoints on the TL.

The select magnets and hold magnets involved in closing the specific crosspoints, depend on the location of the tandem trunk on the line switch and the OGT location on the trunk switch and the channel selected. On a tandem call, the network connection is almost identical to the network connection on an outgoing call. See SFD and SCD C5 for detailed description of channel selection and hold magnet operation.

SECTION G, PART 8

COMPLETING MARKER RELEASE AND OUTGOING SENDER OPERATION

Index

		PAGE
G8	COMPLETING MARKER RELEASE AND OUTGOING SENDER OPERATION	G8-3
G8-1	COMPLETING MARKER RELEASE	G8-3
G8-1.1	MARKER NORMAL RELEASE - OPERATION OF THE DIS1,2 RELAYS (SFD-G805)	G8-3
G8-1.1.1	Trouble Record - Operation of the TRR Relay (SFD-G805)	G8-3
G8-1.2	MARKER TROUBLE RELEASE - OPERATION OF THE TRL RELAY (SFD-G805)	G8-4
G8-1.2.1	Trouble Record - Operation of the TR1 Relay (SFD-G805)	G8-4
G8-1.3	MARKER OVERALL TIME-OUT RELEASE - OPERATION OF THE MRL, MRL1 RELAYS (SFD-C137)	G8-4
G8-1.4	CONTROL OF MARKER RELEASE BY THE MASTER TEST CONTROL CIRCUIT (SFD-G804 AND G805)	G8-5
G8-1.4.1	Requesting Trouble Record Using MTC Circuit - Operation of the REC Relay (SFD-G805)	G8-5
G8-1.5	TROUBLE RECORDER REQUESTS (SFD-G807)	G8-6
G8-1.5.1	Trouble Recorder Busy (SFD-G807)	G8-6
G8-2	MF SENDER OPERATION	G8-6
G8-2.1	MF SENDER - DIGIT REGISTRATION (SFD-G810)	G8-7
G8-2.2	MF SENDER - ARBITRARY DIGIT REGISTRATION - AR, BR, AND CR DIGIT REGISTERS (SFD-G810)	G8-7
G8-2.3	MF SENDER - STEERING CIRCUIT (SFD-G811)	G8-7
G8-2.4	MF SENDER - RECAPTURE PRINCIPLE (SFD-G812)	G8-8
G8-2.5	MF SENDER - LAST DIGIT INDICATION (SFD-G810)	G8-8
G8-2.6	MF SENDER - TRUNK GUARD TEST	G8-9
G8-2.7	MF SENDER - TRUNK TEST TIMING (SFD-G813)	G8-9
G8-2.8	MF INTERSENDER TIMING (SFD-G813)	G8-9
G8-2.9	MF SENDER - REGULAR CLASS - OPERATION OF THE TG AND OF RELAYS (SFD-G816)	G8-10
G8-2.10	MF SENDER - START PULSING SIGNAL (SFD-G817)	G8-10
G8-2.11	MF SENDER - PULSE GENERATOR (SFD-G813)	G8-10
G8-2.12	MF SENDER - GENERATION OF FREQUENCIES (SD-26051-FS12)	G8-11
G8-2.13	MF SENDER - ASSIGNMENT OF FREQUENCIES	G8-11
G8-2.14	MF SENDER - TRANSMISSION OF FREQUENCIES (SFD-G816 AND G817)	G8-12
G8-2.15	MF SENDER - TWO-OUT-OF-FIVE CHECK (SFD-G813)	G8-12

G8-2.16	MTC AND AMRST CONTROL OF SENDER OUTPULSING (SFD-G814)	G8-12
G8-2.16.1	Sender Reorder Test - Operation of the ROT Relay (SFD-G814)	G8-13
G8-2.16.2	Start Pulse Signal to AMRST (SFD-G814)	G8-13
G8-2.16.3	End Pulsing Signal to AMRST (SFD-G814)	G8-13
G8-2.16.4	Trouble Block Test - Operation of the TB1 Relay (SFD-G814)	G8-13
G8-2.16.5	Test Completion and Release of AMRST	G8-13
G8-2.17	RELEASE OF MF SENDER (SFD-G815)	G8-13
G8-2.18	MF SENDER - TM TIMER - (SFD-G813)	G8-14
G8-3	DP SENDER OPERATION	G8-14
G8-3.1	DP SENDER - DIGIT REGISTRATION (SFD-G820)	G8-15
G8-3.2	DP SENDER - ARBITRARY DIGIT REGISTRATION - AR, BR, AND CR DIGIT REGISTERS (SFD-G820)	G8-15
G8-3.3	DP SENDER - STEERING CIRCUIT (SFD-G821)	G8-15
G8-3.4	DP SENDER - RECAPTURE PRINCIPLE (SFD-G822)	G8-16
G8-3.5	DP SENDER - CANCEL OFF-HOOK INDICATION (SFD-G820)	G8-16
G8-3.6	DP SENDER - TRUNK GUARD TEST	G8-16
G8-3.7	DP SENDER - TRUNK TEST TIMING (SFD-G823)	G8-17
G8-3.8	DP INTERSENDER TIMING (SFD-G823)	G8-17
G8-3.9	DP SENDER - REGULAR CLASS - OPERATION OF THE TG AND OF RELAYS (SFD-G826)	G8-17
G8-3.10	DP SENDER - START PULSING SIGNAL (SFD-G824)	G8-18
G8-3.11	DP SENDER - PULSE GENERATOR (SFD-G823)	G8-18
G8-3.12	DP SENDER - PULSE COUNTING CIRCUIT - OPERATION OF THE P1 THROUGH P5 RELAYS (SFD-G823)	G8-19
G8-3.13	DP SENDER - DIGIT CONTROL CIRCUIT (SFD-G825)	G8-20
G8-3.14	DP SENDER - TRANSMISSION OF DIAL PULSES (SFD-G826 AND G827)	G8-21
G8-3.15	RELEASE OF DP SENDER (SFD-G824)	G8-22
G8-3.16	DP SENDER - TM TIMER (SFD-G823)	G8-22

G8 COMPLETING MARKER RELEASE AND OUTGOING SENDER OPERATION

On a TOG call, the CM selects the trunk and outgoing sender of the proper type. When the connection to the sender is completed the CM passes the digits of the called number to the sender where they are stored for subsequent use. The marker then connects the trunk and sender at the sender link frame. When this part of the operation is complete, the marker connects to the proper line link frame appearance of the incoming tandem trunk and proceeds to select the transmission path. After the marker establishes a path, it releases the incoming register and then releases itself from the call. The connection between the OGT and sender is retained until the sender transmits the called number over the OGT to the connecting office.

G8-1 COMPLETING MARKER RELEASE

The marker may encounter numerous conditions that require disconnect, and when these conditions occur, the marker has various methods of disconnection.

G8-1.1 MARKER NORMAL RELEASE - OPERATION OF THE DIS1,2 RELAYS (SFD-G805)

When the marker has completed all functions successfully without encountering any trouble the Linkage Check (LK1) relay will operate causing the Disconnected (DIS1,2) relays in the CM to operate.

The DIS1,2 relays operating, release the CKG1,2 relays in the CM and grounds the MRL lead into the Incoming Register (IR) to operate the MRL relay (SFD-G207). The MRL relay, operating, releases the MS- relay in the IRMC, and by opening the start lead into the connector prevents a second trial (SFD-G204).

G8-1.1.1 Trouble Record - Operation of the TRR Relay (SFD-G805)

There are conditions whereby the CM detects trouble and, before releasing, takes a trouble record by operating the Trouble Record Regular (TRR) release relay. These conditions are as follows on the incoming portion of the tandem call.

When the start lead is shifted to an alternate marker in the IRMC due to a delay in the selection of a marker the Transfer Start (TRS) relay in the PC circuit operates. After an alternate marker is selected, the TRS relay in the CM operates. The TRS relay operates the TRR relay in the CM and a trouble record is then taken. The TRS trouble record is used to identify the connector used on the call.

If the F terminal of a number in the NG is connected to the PBN or PMO lead, the CM will cause the line busy or overflow signal to be returned on calls to these numbers (SFD-D414). When the trouble record is completed, the DIS1,2 relays in the CM operate from the operated RDL, TRB1, TRSA, and TRR relays. The marker then releases on a normal basis.

G8-1.2 MARKER TROUBLE RELEASE - OPERATION OF THE TRL RELAY (SFD-G805)

If the CM encounters trouble while trying to complete the call, Trouble Release (TRL) relay in the marker will operate. The TRL relay operating releases the CKG1,2 relays in the CM and grounds the TRL lead into the Preference Control (PC) circuit operating the TRL relay (SFD-G207). The TRL and TR relays operating release the Marker Start (MS-) relay in the IRMC. The Z relay in the PC changing condition shifts the Start Lead (ST) to the alternate marker and a second attempt is made to complete the call (SFD-G204). A trouble release permits a second trial providing the MRL or TRL relays in the IR are normal.

G8-1.2.1 Trouble Record - Operation of the TR1 Relay (SFD-G805)

There are conditions whereby the CM detects trouble and, before releasing, takes a trouble record by operating the trouble record trouble release TR1 relay. These conditions are as follows.

A time-out or cross failure will cause the CM to take a trouble record. If the marker usage is a first trial (TR2C relay normal), the TR1 relay in the CM operates and a trouble record is taken. A second trial is possible on this type of call because the IR is still attached to the circuit. If the marker usage is a second trial, TR2C relay operated, the TR1 relay in the CM operates and a trouble record is taken. Since the marker usage is a second trial, the TRL relay in the IR will operate opening the start lead preventing another attempt to complete the call.

When the trouble record is completed, the TRL relay in the CM operates from the operated TR1, TRB1, RDL, and TRSA relays. The marker then releases on a trouble basis.

G7-1.3 MARKER OVERALL TIME OUT RELEASE - OPERATION OF THE MRL, MRL1 RELAYS (SFD-G207, G805)

If the marker fails to complete the call within the allotted interval of 9.6 to 15.4 seconds, the OAT timer functions and causes the Marker Release (MRL) relay in the CM to operate. The MRL relay operates the MRL1

relay (SFD-G805) which operates the TRL and MRL relays in the IR (SFD-G207). The MRL relay operating releases the MS- and connector relays in the IRMC and by opening the start lead into the connector prevents a second trial (SFD-G204). The MRL relay in the IR operated opens the locking path of the TRL allowing the TRL relay to release.

On this type of release, a trouble record is not taken but the Timing Alarm (TA) lamp will be lighted on the right COM EQPT marker frame.

G8-1.4 CONTROL OF MARKER RELEASE BY THE MASTER TEST CONTROL CIRCUIT (SFD-G804 AND G805)

On test calls certain Marker Test (MT-) relays operate in the CM. These test relays operating allow the MTC circuit to interact with the marker.

With the MT17 relay operated in the CM, the DCT1 relay operating path is extended into the MTC circuit over the TDCT lead. The DCT1 relay operating ground is extended over the DCT lead into the MTC circuit to operate the DCT relay in the MTC. With the REC key normal, the operation of the DCT relay in the MTC circuit operates the MO1 relay (SFD-G805). The MO1 relay in the MTC circuit operating connects ground to the TDCT lead into the CM operating the DCT1 relay (SFD-G804). The CM then continues its progress on a normal basis.

With the MT1 relay operated in the CM, the DIS1,2 relays operating path is extended into the MTC circuit over the DIS lead. After the LK1 relay in the CM operates, ground is extended over the LK2 lead into the MTC circuit. The LK2 relay in the MTC operates, lighting the LK2 lamp. Ground is now transmitted over the LK3 lead through the CM and back into the MTC on the DIS1 lead. The DIS1,2 relays in the MTC circuit operate, lighting the DIS1 lamp, and ground is extended over the DIS lead into the CM operating the DIS1,2 relays. The CM then gives a normal release. It may be noted that if the LK2 and DIS1 lamp at the MTC panel are both lighted, the marker has completed setting up the connection and released.

G8-1.4.1 Requesting Trouble Record Using MTC Circuit - Operation of the REC Relay (SFD-G805, G807)

When it is desired to obtain a record of the progress of the CM when making a test call, the Record Request (REC) key should be operated at the MTC panel. The REC key operates the REC relay in the MTC after the DCT relay has operated. Thus, the REC relay is operated prior to the completing marker DCT1 relay. The REC relay operated extends ground into the CM over the TRR lead to operate the TRR relay. The TRR relay

operates the Trouble Recorder Start (TRST) relay in the CM which operates the Marker Preference (MPR-) relay in the MTFC to request a trouble record. A trouble record is taken and the CM releases on a normal basis. These trouble records requested by the test equipment can be distinguished from service or legitimate trouble records by the absence of the Trouble Indication (TI) punch on the trouble record card.

G8-1.5 TROUBLE RECORDER REQUESTS (SFD-G807)

When the marker encounters a trouble condition, the TRR or TR1 relay will operate in the CM and cause the trouble recorder to be seized by the trouble recorder start relay operating (SFD-G805). The TRST operates the TRSA relay in the marker. On first trial calls, the MN relay in the JLK circuit operates and a minor alarm is sounded. On second trial calls, the MJ relay in the JLK circuit operates and a major alarm is sounded. The MPR- relay in the MTFC circuit is then operated from battery on the TRST lead. The MPR- relay connects ground to the CI lead which operates the MKA, MKB, and MKB1 relays in the MTFC. The MKA relay operates the Marker Test Repeat (MTR) relay which operates the Cut-In Connector (CIC) relay in the MTFC and a trouble record is taken.

After the trouble record is complete, ground over the Trouble Recorder Control (TRC) lead from the TRC circuit operates the Trouble Rrecord Complete (TRC and TRC1) relays in the MTFC. The Release Marker (RM) relay in the MTFC operates and ground is transmitted over the TRB lead into the CM to operate the Trouble Recorder Busy (TRB1,2) relays. The TRB1 relay operating removes battery from the TRST lead releasing the MPR- and MKA relays in the MTFC. The TRB2 relay operates the Release Delay (RDL) relay in the marker. The marker will then release on a normal or trouble basis.

G8-1.5.1 Trouble Recorder Busy (G-807)

When a trouble record is requested by the marker with the operation of the TRR or TR1 relays and there is a previous trouble record in progress with the TRB1 relay operated, the Display Lost (DL) relay in the marker will operate. The DL relay operating will cause the DL- lamp in the JLK circuit to light, indicating the loss of a trouble record. The marker will then release on a normal or trouble basis.

G8-2 MF SENDER OPERATION

After the sender is connected to the completing marker, it registers the digits dialed and transmits them over the tip and ring conductors to the distant register or sender. When all digits are transmitted, supervision of the call is turned over to the incoming tandem trunk and the sender releases.

G8-2.1 MF SENDER - DIGIT REGISTRATION (SFD-G810)

The MF sender is designed to handle up to 11 digits. The digits are registered on dry reed relays, A through L, each relay having 5 independent coils with 2 make contacts. The marker operates these independent coils of the digit registration relays on a 2-out-of-5 basis from ground through the OSC circuit.

Since the number of digits an outgoing sender receives on different calls may vary, an indication is needed to mark the end-of-digit registration. This is the end-7 registration and consists of operating only the 7 coil of the digit register one beyond the last registered digit.

The completing marker is able to detect missing digits since the registration must consist of 2-out-of-5 in each position up to the end-7 which is followed by a 0-out-of-5. Should any of the digit registration relay coils in the sender fail to lock operated, the Outgoing Registration Check (ORK1,2) relays in the completing marker will not operate and the punch indication A'(2/5) - L'(2/5) will be missing from the trouble record card.

G8-2.2 MF SENDER-ARBITRARY DIGIT REGISTRATION - AR, BR, AND CR DIGIT REGISTERS (SFD-G810)

Provision is made in the sender for registering up to three arbitrary digits. These arbitrary digits originate in the marker and are used for code conversion and code prefixing. Any digits registered on the arbitrary digit registers will be transmitted ahead of digits registered on the A through L digit registers. These digits are registered on the AR, BR, and CR digit register relays.

G8-2.3 MF SENDER - STEERING CIRCUIT (SFD-G811)

The MF sender digit steering circuit consists of a Key Pulse (KP) relay, one steering relay per digit, AS to LS, a Start Pulse (SP) relay, and an End-of-Pulsing (EP) relay.

When both the Advance (AV) and Auxiliary Timer (ÁTM) relays have operated, the KP relay in the Outgoing Sender (OS) will operate. After the OS receives on-hook supervision, indicated by the Off-Hook (OF) relay in the OS releasing, the SP relay will operate (SFD-G815) to cause the steering relay for the first digit to be transmitted to operate.

The steering relay for the first digit operates through its own normal contacts and locks through the normal contacts of the remaining non-operated steering relays. This steering relay associates the Recapture (RR 2/5) relays with the digit register for the first digit to be

transmitted (SFD-G812). A second make-contact of the steering relay operated transfers the locking circuit for the KP relay from the direct ON1 ground to the operating ground for the digit steering relay (SFD-G811). When this locking circuit is opened, as it will be when the PG1 relay operates to terminate the key pulse signal, KP releases. When the PG1 relay releases, the ON1 ground is closed through the operated steering relay contacts for the first digit to cause the operation of the steering relay for the second digit. The circuit progresses in a similar manner for each digit to be transmitted with the PG1 releasing to cause the operation of the steering relay for the next digit to be transmitted and operating to cause the release of the steering relay for the digit just transmitted.

G8-2.4 MF SENDER - RECAPTURE PRINCIPLE (SFD-G812)

The use of reed-type register relays AR to L with a limited number of contacts, necessitates the use of a set of translating or recapture relays for obtaining additional contacts for use at the time the digit is to be transmitted. The recapture relays consist of five general purpose relays RR-(2/5) (SFD-G812), which are associated with the digit registers successively by the steering circuit. In an MF sender, the recapture relays are used for connecting the proper combination of frequencies to the tip and ring for transmission of the registered digits to the distant office. The recapture relays are also used to operate the EP relay after the last digit is transmitted.

G8-2.5 MF SENDER - LAST DIGIT INDICATION (SFD-G810)

The steering relays control the Last Digit (LD) relay, which is used to indicate the number of digits registered in the sender. Relay LD is operated initially on its primary winding when the ON relay in the sender operates. After the first digit steering relay operates, the locking ground for the digit register relay, two digits beyond, is transferred to the LD relay secondary winding locking circuit. This provides a holding circuit for the LD relay when the primary winding operating path is opened, and enables the sender to determine two digits ahead when a no-digit or end-7 signal is registered on the digit register relay.

After the key pulse signal is transmitted, the primary winding of the LD is opened by the release of the KP relay. With the steering relay for the first digit operated, the second digit steering relay will operate to provide a new holding circuit for the LD relay when the steering relay for the first digit is released. The LD relay will release after the release of the steering relay for the next to last digit registered in the sender.

G8-2.6 MF SENDER - TRUNK GUARD TEST

A trunk test is made by the sender to test for battery and ground on the tip and ring conductors. If the sender finds an open trunk toward the distant office, the marker will time out, take a trouble record, and set the sender to return a reorder signal to the trunk. If the sender recognizes correct supervision and the TG test is performed satisfactorily, the marker will then release on a normal basis. (See SCD-C2 for a more detailed description.)

G8-2.7 MF SENDER - TRUNK TEST TIMING (SFD-G813)

The trunk cover-up interval is timed by the ATM timer. On a regular class call, this interval is timed before the tip and ring loop is closed to insure that the trunk is fully released from a previous connection. After the ON relay in the sender operates connecting the ATM3 resistor to the timing circuit, it will take 460 to 900 milliseconds for the ATM capacitor to become sufficiently charged to operate the auxiliary timer ATM relay. At this time the AV relay in the sender will usually be operated, and when it is operated, the KP relay in the sender will operate and open the circuit for the ATM relay.

The ATM relay releases and, with the KP relay operated, operates the ATC relay in the sender (SFD-G815) to restart the timer for timing the intersender interval.

G8-2.8 MF INTERSENDER TIMING (SFD-G813)

Intersender timing is performed by the ATM timer. After the Auxiliary Timer Control (ATC) relay in the sender operates, the ATM capacitor charging path is through the ATM5 resistor. With the ON and ATC relays operated in the sender, it will take from 4.4 to 8.4 seconds for the ATM capacitor to become sufficiently charged to operate the ATM tube and relay.

Under normal operating conditions, a distant register or sender will be attached to the OS without delay and the SP relay in the sender will operate to open the circuit to the ATM relay before it is able to operate. However, if the connection of a register or sender is delayed beyond 8.4 seconds, the ATM relay will operate and, with the ATC operated, close a path from the winding of the Reorder (RO) relay (SFD-G815) over the WA lead to the outgoing sender group release circuit. The marker finding an all-sender or register busy condition in the distant office will operate the release relay of the sender group release circuit which in turn will ground the WA lead. When the WA lead is grounded, with the SP relay normal, the RO relay will operate to release the sender. Relay RO operates the Overflow (OF) relay (SFD-C213) of the OGT and releases the CT relay causing the sender to release.

G8-2.9 MF SENDER - REGULAR CLASS - OPERATION OF THE TG AND OF RELAYS (SFD-G816)

Regular class includes all one-way trunks except intertoll and any trunk in which the Class (CL2) relay remains normal. The sender requires a change in supervision from off-hook to on-hook as a start pulsing signal. These trunks, in general, are on-hook when normal, change to off-hook when the line is connected to a distant register or sender and then revert to on-hook when the distant end is ready to accept pulses.

When the marker has completed its job of establishing the connection, the sender AV relay has operated, the sender has timed the cover-up interval, and the sender KP relay has operated, the tip and ring leads are closed to the windings of the TG and OF relays in the OS. With the Cut-Off (CO) relay in the incoming trunk normal, the supervision is on-hook and the battery and ground from the A relay in the trunk will operate the outgoing sender Trunk Guard (TG) relay and the OF relay will bias or remain normal. The TG1 relay in the OS then operates and opens the TG lead to the marker. When the CO relay in the incoming trunk operates the supervision is changed to off-hook and the A relay battery and ground is removed from the tip and ring leads. The tip and ring leads are now connected to the IR where the battery and ground from the line supervisory A relay is in a direction to operate the OF relay in the OS. The TG and OF1 relays in the outgoing sender will also operate at this time.

G8-2.10 MF SENDER - START PULSING SIGNAL (SFD-G817)

The outgoing sender must receive a change in supervision from off-hook to on-hook before it can start outpulsing.

The operation of the Reversal (RV) relay in the distant incoming register reverses the polarity of the tip and ring leads to the OS. When the reversal is recognized by the outgoing sender, the OF relay will release changing the supervision to on-hook. The TG relay in the OS will also release, but only momentarily, and then reoperate to cause the SP relay to operate through the still operated, slow-release OF1 relay contacts, and the normal OF relay contacts (SFD-G815).

G8-2.11 MF SENDER - PULSE GENERATOR (SFD-G813)

The pulse generator consists of the PG and PG1 relays and their associated capacitors and resistors. The mercury-type polarized PG relay is nonbiasing and can be operated in both directions to its front or back contacts.

When the ON relay in the sender operates, the PG relay will operate from current flowing through its primary winding. The PG relay will remain operated until the PG capacitor becomes charged and then release through its secondary winding. The PG relay will remain normal until the SP relay in the OS operates.

When the SP relay operates, the PG relay will operate from current flowing through its secondary winding. The PG and SP operated will cause the PG1 relay in the OS to operate. The PG1 relay operating reverses the circuits through both windings of the PG again, causing the PG relay to release. This cycle is repeated as long as the PG relay maintains control of the PG1 relay. When it is desired to stop the pulse generator an alternate circuit to the PG1 relay is closed, thus, preventing release of the PG1 relay and stopping the interrupter.

G8-2.12 MF SENDER - GENERATION OF FREQUENCIES (SD-26051-FS12)

Where it is economical, a frequency generator will be provided per sender. The six multifrequency signals are generated in the sender by transistor oscillators. The power for starting the oscillators is applied when the sender is seized and the ON relay operates (SFD-G816).

G8-2.13 MF SENDER - ASSIGNMENT OF FREQUENCIES

The six frequencies generated in the MF outgoing sender are assigned in steps of 200, from 700 to 1700 cycles. The first five frequencies are assigned on a 2-out-of-5 basis to the digits 0 to 9 and the sixth is used in combination with others of the first five as the key pulse and start pulse signal. The frequencies are assigned designations 0, 1, 2, 4, 7 and 10 so as to fit in with the standard additive 2-out-of-5 code. The frequencies and their assignments are as follows:

	FREQUENCY					
	700	900	1100	1300	1500	1700
DIGIT	DESIGNATION					
	0	1	2	4	7	10
0				x	x	
1	x	x				
2	x		x			
3		x	x			
4	x			x		
5		x		x		
6			x	x		
7	x				x	
8		x			x	
9			x		x	
Key Pulse			x			x
ST Pulse					x	x

G8-2.14 MF SENDER - TRANSMISSION OF FREQUENCIES (SFD-G816 AND G817)

The outgoing sender frequencies are connected to the input side of the repeating coil by the KP and RR-(2/5) relay contacts. When the KP and SP relays in the OS are operated, the key pulse signal (frequencies 2 and 10) is transmitted over the tip and ring leads into the MF receiver at the distant end (SFD-G817). The key pulse signal acts as a gate opener, activating the MF receiver to enable it to start accepting subsequent pulses from the OS. After a timed interval, the PG1 relay in the sender operates, disconnecting the key pulse signal from the tip and ring leads to release the KP relay. When the PG1 relay releases, the frequencies for the first digit (stored on the RR2/5 relays) are transmitted over the tip and ring leads into the MF receiver. After a timed interval, the PG1 relay will again operate, disconnecting the frequencies associated with the first digit from the tip and ring leads. The PG1 relay operating, releases the steering relay for the first digit, thus, placing the RR2/5 relays under control of the next digit steering relay (SFD-G812). As the PG1 relay releases and reoperates, the process just described will continue until all digits have been transmitted.

After all registered digits have been transmitted, the RR2/5 relays will be associated with a digit register relay which has only the -7 relay operated. This will cause the start pulse signal, frequencies 7 and 10, to be transmitted over the tip and ring leads to notify the MF receiver at the distant end that all of the digits have been transmitted. The PG1 relay will then operate to terminate the start pulse signal and release the steering relay. With all of the RR- relays normal the EP relay will operate to start the release of the sender.

G8-2.15 MF SENDER - TWO-OUT-OF-FIVE CHECK (SFD-G813)

A feature is provided in the pulse generator circuit to check that only two of the five recapture RR-(2/5) relays are operated for each digit transmitted. As the recapture relays are transferred from one digit to the next, the PG1 relay will not release to advance to send the next digit unless the 2/5 check is satisfied. If the PG1 relay fails to release, the timing circuit will function and cause the sender to release.

G8-2.16 MTC AND AMRST CONTROL OF SENDER OUTPULSING (SFD-G814)

On test calls the Master Test Control (MTC) circuit is used to prime the completing marker and establish the connection between the AMRST circuit and the OS. The AMRST, after being connected to the outgoing sender by the operation of the M relay in the sender, monitors the operations in the sender by receiving data over a number of leads.

G8-2.16.1 Sender Reorder Test - Operation of the ROT Relay (SFD-G814)

To simulate a reorder condition in the OS using the MTC circuit, the Reorder Test (ROT) key should be operated at the MTC panel. The ROT key operates the ROT relay in the MTC circuit. With the Connect Originating Class (KOR) relay operated, ground is transmitted over the ROT lead through the MTFC, CM, and OSC into the sender and operates the RO relay. When the sender returns the locking ground over the RO lead the CK2 relay in the MTC circuit operates. The CK1 relay will then operate lighting the CK1 lamp.

G8-2.16.2 Start Pulse Signal to AMRST (SFD-G814)

When the sender is ready to start outpulsing and the AMRST circuit is attached to the sender by the M relay, operating ground is transmitted over the PL lead to operate the DSM (dial pulse) or Pulsing (PL) relay in the AMRST depending upon the type of sender used. The pulses are then received and checked by the AMRST.

G8-2.16.3 End Pulsing Signal to AMRST (SFD-G814)

After outpulsing has been concluded and the sender EP relay has operated, ground is connected to the SPE lead into the AMRST circuit operating the pulse end SPE or SPE1 relay, depending upon the type sender used.

G8-2.16.4 Trouble Block Test - Operation of the TB1 Relay (SFD-G814)

On a test call, as the result of a test failure, the Trouble Block Test (TB1) relay in the AMRST circuit operates. This causes Trouble (TBL) relay in the AMRST circuit to operate, lighting the TBL lamp.

G8-2.16.5 Test Completion and Release of AMRST

On a test call when the sender starts to release the Test Abandoned Call (TAC2) relay operates in the AMRST circuit. The OK relay will then operate, lighting the OK lamp and will release the sender (followed by the AMRST circuit). However, the AMRST circuit will not release completely until the STT key is restored to normal.

G8-2.17 RELEASE OF THE MF SENDER (SFD-G815)

The MF sender is designed to outpulse the registered digits and then turn the supervision over to the trunk and release. After the last digit has been transmitted, all of the RR2/5 relays will remain normal and cause the EP relay to operate. The EP relay operating, releases the outgoing trunk D relay and the sender Cut-Through (CT) relay. The Line Release (LR) relay will then release causing the ON and ON1 relays in the sender to release. After the ON1 relay releases, the Sender Busy (SB) relay releases reclosing the busy test leads, restoring the sender to normal.

G8-2.18 MF SENDER - TM TIMER (SFD-G813)

The sender TM timer measures the interval between the seizure and release of the sender. If the sender operation is not completed within the allowable interval of 12.7 to 24 seconds, the TM timer functions and operates the TM relay in the OS.

The TM relay operates the TRL relay in the sender (SFD-G815), which grounds the stuck sender register lead SS into the plant register circuit, grounds the LP lead into the JLK circuit, lighting the TO lamp, grounds the ALM lead into the JLK circuit to start the office timer, and operates the RO relay in the sender (SFD-G815). The RO relay operating connects a resistance battery to the AB lead through the OSL to operate the marginal overflow OF relay in the OGT, transfers the LR relay from the AB lead to an ON ground, and releases the slow release CT relay (SFD-C213). Relay CT in releasing disconnects the resistance battery from the AB lead, disconnects ground from the stuck sender plant register lead, and releases the LR relay in the sender.

If the Cancel Timed Release (CTR) key on the JLK bay is normal (pushed in) the release of the LR relay will cause the release of the ON relay followed by other operated relays in the sender. The TRL relay will release from the ON1 and remove grounds from the LP and ALM leads into the JLK circuit (SFD-G815). If the CTR key is operated (pulled out) the ON relay will be held operated through the TRL contacts (SFD-C213) and will maintain the grounds on the LP and ALM leads into the JLK circuit. The ground on the LP lead will light the TO lamp (SFD-G815) while the ground on the ALM will cause the major alarm to operate with the register sender time-out alarm indication. If the sender MB relay is operated by the insertion of a plug in the MB jack at the JLK bay, the ground is removed from the ALM lead which retires the major alarm and leaves the TO lamp lighted. When the CTR key is restored to normal (pushed in), the ON relay will release, allowing the release of the operated relays in the sender. When the ON1 relay releases, the TRL relay releases and extinguishes the TO lamp.

G8-3 DP SENDER OPERATION

After the sender is connected to the completing marker, it registers the digits dialed and transmits them over the tip and ring conductors to the distant register or sender. When all the digits are transmitted, supervision of the call is turned over to the incoming tandem trunk trunk and the sender releases.

G8-3.1 DP SENDER - DIGIT REGISTRATION (SFD-G820)

The DP sender is designed to handle up to 11 digits, as recorded in the originating register. The digits are registered on dry reed relays, A through L, each relay having 5 independent coils with 2 make contacts. The marker operates these independent coils of the digit registration relays on a 2-out-of-5 basis from battery through the OSC circuit.

Since the number of digits an outgoing sender receives on different calls may vary, an indication is needed to mark the end-of-digit registration. This is the end-7 registration and consists of operating only the 7 coil of the digit register one beyond the last registered digit.

The completing marker is able to detect missing digits since the registration must consist of 2-out-of-5 in each position up to the end-7 which is followed by a 0-out-of-5.

Should any of the digit registration relay coils in the sender fail to lock operated, the ORK1,2 relays in the completing marker would not operate and the punch indication A'(2/5) - L'(2/5) would be missing from the trouble record card.

G8-3.2 DP SENDER - ARBITRARY DIGIT REGISTRATION - AR, BR, AND CR DIGIT REGISTERS (SFD-G820)

Provision is made in the sender for registering up to three arbitrary digits. These arbitrary digits originate in the marker and are used for code conversion and code prefixing. Any digits registered on the arbitrary digit registers will be transmitted ahead of digits registered on the A through L digit registers. These digits are registered on the AR, BR, and CR digit register relays.

G8-3.3 DP SENDER - STEERING CIRCUIT (SFD-G821)

The DP sender digit steering circuit consists of one steering relay per digit, AS to LS.

When both the AV and Off-Normal (ON1) relays have operated in the Outgoing Sender (OS), the steering relay for the first digit to be transmitted will operate.

The steering relay for the first digit operates through its own normal contacts and locks through the normal contacts of the remaining non-operated steering relays. This steering relay associates the RR(2/5) relays with the digit register for the first digit to be transmitted (SFD-G822). After the OS receives on-hook supervision, indicated by the off-hook OF relay in the OS releasing, the Trunk Test Completed (TT1) relay in the OS will operate (SFD-G824) to cause the operation of the steering relay for the second digit.

When transmission of the first digit is completed, the Z relay in the OS will operate and cause the steering relay for the first digit to release (SFD-G821). The second digit steering relay is now controlling the operation of the RR(2/5) relays. The circuit progresses in a similar manner for each digit to be transmitted with the Z relay releasing to cause the operation of the steering relay for the next digit to be transmitted and operating to cause the release of the steering relay for the digit just transmitted.

G8-3.4 DP SENDER - RECAPTURE PRINCIPLE (SFD-G822)

The use of reed-type register relays AR to L with a limited number of contacts, necessitates the use of a set of translating or recapture relays for obtaining additional contacts for use at the time the digit is to be transmitted. The recapture relays consist of 5 general purpose relays RR(2/5) (SFD-G822), which are associated with the digit registers successively by the steering circuit. In a DP sender, the recapture relays are used to change the 2-out-of-5 registration to a 1-out-of-10 translation for control of the dial pulse generator (SFD-G825). The recapture relays are also used to operate the EP relay after the last digit is transmitted.

G8-3.5 DP SENDER - CANCEL OFF-HOOK INDICATION (SFD-G820)

The steering relays control the Cancel Off-Hook (COF) relay, which is used to indicate the number of digits registered in the sender. Relay COF is operated initially on its primary winding when the ON1 relay in the sender operates. After the first digit steering relay operates, the locking ground for the digit register relay, two digits beyond, is transferred to the COF relay secondary winding locking circuit. This provides a holding circuit for the COF relay when the primary winding operating path is opened, and enables the sender to determine two digits ahead when a no-digit or end-7 signal is registered on the register relay.

Before the first digit is transmitted, the primary winding of the COF is opened by the operation of the TT1 relay. With the steering relay for the first digit operated, the second digit steering relay will operate to provide a new holding circuit for the COF relay when the steering relay for the first digit is released. The COF relay will release after release of the steering relay for the next-to-last digit registered in the sender.

G8-3.6 DP SENDER - TRUNK GUARD TEST

A trunk test is made by the sender to test for battery and ground on the tip and ring conductors. If the sender finds an open trunk toward the distant office, the marker will time-out, take a trouble record, and set the sender to return a reorder signal to the trunk. If the sender recognizes correct supervision and the TG test is performed satisfactorily, the marker will then release on a normal basis. (See SCD-C2 for a more detailed description.)

G8-3.7 DP SENDER - TRUNK TEST TIMING (SFD-G823)

The trunk cover-up interval is timed by the ATM timer. On a regular class call, this interval is timed before the tip and ring loop is closed to insure that the trunk is fully released from a previous connection. After the ATC relay in the sender operates connecting the ATM3 resistor to the timing circuit, it will take 0.62 to 1.2 seconds for the ATM capacitor to become sufficiently charged to operate the ATM relay. At this time the AV relay in the sender will usually be operated, and when it is operated, the ATC relay in the sender will release and open the circuit for the ATM relay.

The ATM relay releases and, with the TTK relay operated, operates the ATC1 relay in the sender (SFD-G824) to restart the timer for timing the intersender interval.

G8-3.8 DP INTERSENDER TIMING (SFD-G823, G824)

Intersender timing is performed by the ATM timer. After the ATC1 relay operates, the ATC relay in the sender will reoperate. With the TTK, ATC1, and ATC relays in the sender operated, the ATM5 resistor becomes effective in the ATM capacitor charging circuit. It will take from 4.4 to 8.4 seconds for the ATM capacitor to become sufficiently charged to operate the ATM tube and relay.

Under normal operating conditions, a distant register or sender will be attached to the OS without delay and the TT1 relay in the sender will operate to release the ATC relay and open the circuit to the ATM relay before the ATM relay is able to operate. However, if the connection of a register or sender is delayed beyond 8.4 seconds, the ATM relay will operate and, with the ATC1 operated, close a path from the winding of the RO relay (SFD-G824) over the WA lead to the outgoing sender group release circuit. The marker finding an all-sender or all-register busy condition in the distant office will operate the release relay of the sender group release circuit which in turn will ground the WA lead. When the WA lead is grounded the RO relay will operate to release the sender. Relay RO operates the Overflow (OF) relay (SFD-C213) of the outgoing trunk circuit and releases the CT relay allowing the sender to release.

G8-3.9 DP SENDER - REGULAR CLASS - OPERATION OF THE TG AND OF RELAYS (SFD-G826)

Regular class includes all one-way trunks except intertoll and any trunk in which the CL2 relay remains normal. The sender requires a change in supervision from off-hook to on-hook as a start pulsing signal. These trunks, in general, are on-hook when normal, change to off-hook when the line is connected to a distant register or sender and then revert to on-hook when the distant end is ready to accept pulses.

When the marker has completed its job of establishing the connection, the sender AV relay will operate. The AV relay will operate the BD relay in the OS to remove the short from around the TG and OF relay windings. The BD relay operating will close the tip and ring leads to the windings of the TG and OF relays in the OS. With the Cut-Off (CO) relay in the incoming trunk normal, the supervision is on-hook and the battery and ground from the A relay in the incoming trunk will operate the outgoing sender Trunk Guard (TG) relay and the OF (off-hook) relay will bias or remain normal. The TG1 relay in the OS then operates and opens the TG lead to the marker. When the CO relay in the incoming trunk operates, the supervision is changed to off-hook and the A relay battery and ground is removed from the tip and ring leads. The tip and ring leads are now connected to the IRDP where the battery and ground from the line supervisory L relay is in a direction to operate the OF relay in the OS. The TG and TT relays in the outgoing sender will also operate at this time.

G8-3.10 DP SENDER - START PULSING SIGNAL (SFD-G824)

The outgoing sender must receive a change in supervision from off-hook to on-hook before it may start outpulsing.

The operation of the RV relay in the distant incoming register reverses the polarity of the tip and ring leads to the OS. When the reversal is recognized by the outgoing sender, the OF relay will release changing the supervision to on-hook. The TG relay in the OS will also release but only momentarily and then reoperate to cause the trunk test completed TT1 relay to operate through the normal OF relay contacts (SFD-G824). The TT1 relay operates the digit steering relay for the second digit and also places the sender P relay under control of the BD, W, and SP relays (SFD-G823). The ATC1 relay will also release, followed by the TGT and BD relays, which allows the first digit to be dial pulsed.

G8-3.11 DP SENDER - PULSE GENERATOR (SFD-G823)

The pulse generator consists of the P and PG relays, and their associated capacitors and resistors. The mercury-type PG (polarized) relay is non-biasing and can be operated in both directions to its front or back contacts.

When the ON relay operates, the P relay in the OS will operate through the SP, W, and TT1 relays normal. The PG relay will then operate from current flowing through its primary winding. The PG relay will remain operated until the PG capacitor becomes charged and then release through its secondary winding. The PG relay will remain normal until the P relay in the OS releases.

When the P relay releases, the PG relay will operate from current flowing through its secondary winding. The PG relay operating causes the P

relay to reoperate, reversing the circuits through both windings of the PG again, causing the PG relay to release. This cycle is repeated as long as the PG relay maintains control of the P relay. When it is desired to stop the pulse generator, an alternate circuit to the P relay is closed, thus, preventing release of the P relay and stopping the interrupter.

G8-3.12 DP SENDER - PULSE COUNTING CIRCUIT - OPERATION OF THE P1 THROUGH P5 RELAYS (SFD-G823)

The DP sender counting circuit is used to count the number of dial pulses generated in the OS and then recycled to count the interdigital interval pulses.

The DP counting circuit consists of relays P1 through P5. The P1 and P2 relays are wired as a pulse divider and the P3, P4, and P5 relays are used in various combinations to count and remember the number of operations of P1 and P2. These relays are controlled by the sender P relay operating and releasing. When the ON relay operates, the P and LR relays in the OS operate. After the trunk test completed TT1 relay operates, the P relay releases and causes the P1 relay in the OS to operate. At the end of the first open pulse the P relay will reoperate to operate relay P2. On the next release of P, the P2 relay releases. This cycle is repeated with the P1 and P2 relays remaining operated at the end of each odd numbered pulse and normal at the end of each even numbered pulse.

The counting circuit has a feature which enables it to detect when a count of more than 10 pulses is reached. This condition will leave the P5 operated with the P3 and P4 relays normal. If this condition is reached, the TRL relay in the OS will operate, indicating a trouble condition exists (SFD-G825).

The following table gives a sequence of these operations.

Pulse	P	P1	P2	P3	P4	P5	Counting Relays Remaining Operated
1	RLS	O					
	OPR		O				P1, P2
2	RLS	R		O			
	OPR		R				P3
3	RLS	O					
	OPR		O		O		P1, P2, P3, P4
4	RLS	R					
	OPR		R				P3, P4
5	RLS	O		R			
	OPR		O				P1, P2, P4
6	RLS	R					
	OPR		R			O	P4, P5
7	RLS	O					
	OPR		O				P1, P2, P4, P5
8	RLS	R		O			
	OPR		R				P3, P4, P5
9	RLS	O					
	OPR		O		R		P1, P2, P3, P5
10	RLS	R					
	OPR		R				P3, P5
11	RLS	O		R			
	OPR		O				P1, P2, P5
12	RLS	R					
	OPR		R				P5

G8-3.13 DP SENDER - DIGIT CONTROL CIRCUIT (SFD-G825)

The digit control circuit consists of the Between Digit (BD) relay, the SP relay, and the function dividing relays W and Z.

When the AV relay has operated, the BD relay in the OS operates removing the short from the TG and OF relay windings (SFD-G826). After the trunk test has been completed the TT1 relay in the OS operates releasing the BD relay allowing the first digit to be dial pulsed.

The SP relay is used to terminate the dial pulses for each digit and for each interdigital interval. As the DP generator functions, the number of P relay operations is counted on the P1 to P5 relays. The SP winding is connected to the P1 to P5 relay contacts which are wired to the corresponding RR-(2/5) relays or through the Z relay contacts. When the P- relays have counted to the combination closed by the operated RR-(2/5) relays, the ON ground will operate the SP relay. One-half pulse cycle later, with the SP operated and P normal, the P1 through P5 counting relays are recycled and release. The SP relay operating also operates the W relay. The SP relay will release one pulse cycle later when the P relay operates. When the W relay is operated, the SP relay releasing will operate the Z relay. The Z relay operates the BD relay in the OS enabling the supervisory TG and OF relays. The Z relay also closes a circuit around the RR- relay contact to the P-, counting relay, contacts controlling the SP relay operation after a predetermined number of interdigital pulse cycles of the pulse generator. The number of interdigital pulse cycles is determined by the ID to ID- cross-connect (SFD-G825). The ID to ID5 cross-connect allows for an interdigital interval of 5 1/2 pulse cycles. At the end of the fourth interdigital pulse, with the P and Z relays operated, the SP relay operates and releases the W relay. At the end of the fifth interdigital pulse, the P relay operating releases the SP followed by the Z and BD relays. With both the W and SP relays normal, the next release of relay P opens the tip and ring conductors (SFD-G826). With the Z relay normal, the SP relay is again under the control of the RR-(2/5) relays. The release of the SP relay also releases the BD relay allowing the next digit to be dial pulsed.

This entire operation can be summarized as follows and is repeated for each digit. The BD relay releases and the digit is dial pulsed. The SP relay operates to terminate the digit and operates the W relay and recycles the counting relays. The SP relay releases, operating the Z relay which sets the counting relays to count to the interdigital interval and operates the BD relay. At the end of the fourth interdigital pulse, the SP relay operates releasing the W relay and recycling the counting relays. At the end of the fifth interdigital pulse, the SP relay releases followed by the Z which places the SP relay under the control of the P1 to P5 counting and RR-(2/5) relays. The SP releasing also releases the BD relay allowing the next digit to be dial pulsed.

G8-3.14 DP SENDER - TRANSMISSION OF DIAL PULSES (SFD-G826 AND H827)

After the OS receives on-hook supervision and the TT1 relay has operated, the BD relay in the OS will release causing the P relay in the pulse generator circuit to release (SFD-G823). The P relay in the OS releases the L relay in the distant IRDP. When the P relay reoperates, the L relay will also reoperate. With the BD and SP relays normal, the P relay in the OS (releasing and operating) opens and closes the tip and ring conductors which release and operates the L relay in the IRDP.

As long as the P relay maintains control of the tip and ring closure, the L relay in the IRDP will count the dial pulses transmitted by the OS.

When the SP relay in the OS operates, an auxiliary tip and ring closure is established around the P relay contacts and the L relay in the IR will remain operated. This indicates to the IR the end of the digit pulses and the start of the interdigital interval in the OS.

G8-3.15 RELEASE OF DP SENDER (SFD-G824)

The DP sender is designed to outpulse the registered digits and then turn the supervision over to the trunk and release. After the last digit has been dial pulsed the SP relay in the OS operates releasing the P1 to P5 counting relays. One pulse cycle later, when the P relay operates, the SP relay will release operating the Z relay which releases the last digit steering relay. The last digit steering relay releasing will place the RR-(2/5) relays under control of the last operated steering relay and the digit registration relay having only the -7 operated. This will cause only the RR7 relay to operate. With the COF relay normal and the TT1 relay operated, the EP relay will operate through the normal RR0,1,2, and 4 relays. The EP relay operating will close an auxiliary circuit to relay P holding it operated and stopping the pulse generator. The EP relay operating also releases the outgoing trunk D relay and the sender CT relay. The LR relay will then release causing the ON and ON1 relays in the sender to release. After the ON1 relay releases, the SB relay releases reclosing the busy test leads restoring the sender to normal.

G8-3.16 DP SENDER TM TIMER (SFD-G823)

The sender TM timer measures the interval between the seizure and release of the sender. If the sender operation is not completed within the allowable interval of 19 to 37 seconds, the TM timer functions and operates the TM relay in the OS.

The TM relay operates the TRL relay in the sender (SFD-G824), which grounds the Stuck Sender (SS) register lead into the plant register circuit, grounds the LP lead into the JLK circuit lighting the TO lamp, grounds the ALM lead into the JLK circuit to start the office timer, and operates the RO relay in the sender (SFD-G824). The RO relay operating connects a resistance battery to the AB lead through the OSL to operate the marginal OF (overflow) relay in the OGT, transfers the LR relay from the AB lead to an ON ground, and releases the slow release CT relay (SFD-C213). Relay CT in releasing disconnects the resistance battery from the AB lead, disconnects ground from the stuck sender plant register lead, and releases the LR relay in the sender.

If the Cancelled Timed Release (CTR) key on the JLK bay is normal (pushed in) the release of the LR relay will cause the release of the ON relay followed by other operated relays in the sender. The TRL relay will release from the ON1 and remove the grounds from the LP and ALM leads into the JLK circuit (SFD-G824). If the CTR key is operated (pulled out) the ON relay will be held operated through the TRL contacts (SFD-C213) and will maintain the grounds on the LP and ALM leads into the JLK circuit. The ground on the LP lead will light the TO lamp (SFD-G824) while the ground on the ALM will cause the major alarm to operate with the register sender time-out alarm indication. If the sender MB relay is operated by the insertion of a plug in the MB jack at the JLK bay the ground is removed from the ALM lead retiring the major alarm leaving the TO lamp still lighted. When the CTR key is restored to normal (pushed in), the ON relay will release, allowing the release of the operated relays in the sender. When the ON1 relay releases the TRL relay releases and extinguishes the TO lamp.

SECTION G, PART 9

MAINTENANCE

Index

		PAGE
G9	MAINTENANCE	G9-2
G9-1	USE OF THE MASTER TEST CONTROL FRAME TO SIMULATE CALLS WHICH PRODUCE TROUBLE RECORD CARDS	G9-2
G9-2	USE OF SIMULATED TABLE AND ILLUSTRATED RECORD CARD	G9-2
G9-3	FUNCTIONS OF TANDEM OUTGOING (TOG) CALL	G9-3
G9-4	USE OF CLASS OF TEST TABLES	G9-5
G9-5	MARKER TEST - TANDEM CLASS	G9-5
G9-6	INCOMING TANDEM TRUNK TEST (ITNP) CLASS OF TEST	G9-6
G9-7	OGT TRUNK TEST - TANDEM CLASS	G9-6

G9 MAINTENANCE

This part of the G section covers some of the aspects of the use of the master test control frame to detect, locate and clear trouble on tandem outgoing calls.

G9-1 USE OF THE MASTER TEST CONTROL FRAME TO SIMULATE CALLS WHICH PRODUCE TROUBLE RECORD CARDS

Use of trouble record cards using the trouble analysis chart and sequence charts of part G0 localizes the trouble to an area which may involve a path through one or two relay contacts within one circuit or may involve a path through many relay contacts in several circuits. Generally, it is not possible to troubleshoot the path on a static basis. The contacts which close to establish the path are often closed for only a portion of a second during marker holding time. Frequently, the path which produced the failure is only used when a particular configuration of circuits or network paths are used. For this reason, it is desirable to be able to reproduce the same condition which caused the troubles in the first place, the master test control circuit provides the means for such controlled simulation of actual calls without affecting service.

G9-2 USE OF SIMULATED TABLE AND ILLUSTRATED RECORD CARD

The purpose of the simulation tables in SFD-G902, G904, G906, is to correlate trouble record card designations with the key(s) or switch(es) of the master test control frame which should be operated to provide input or control to the CM when simulating a trouble record card. Included for easier reference, is a trouble card designation location for different types of trouble cards. The three types of trouble record cards illustrated are E-5488 (2/X double sided) shown on SFD-G903, E-4393 (1X double sided) shown on G905, and E-3638 (1X single sided) shown on SFD-G907.

The drawing in SFD-G903, G905, G907 depict a trouble record card which includes all of the possible designations (colored) which might be perforated on a record produced by a tandem outgoing type of call. A color key arrangement is used to indicate the different functions of designations regarding marker input or output information, progress of call, circuits or paths used, etc.

G9-3 FUNCTIONS OF TANDEM OUTGOING (TOG) CALL

One of the tables on SFD-G902, G904, or G906 and the associated colored trouble record card which corresponds to the type of trouble record card being analyzed should be used. The tables are divided into two parts. The left hand side of the chart shows functions used, designations perforated, and the designation location on a particular trouble record card. The right hand side of the chart lists the different key(s) or switch(es) used to simulate trouble record indications, depending on the type of master test control frame provided. The following is a brief description of the key and switch arrangements and their relationship to the trouble designation for each of the functions listed in about tables.

(a) Select the TOG class of marker test, by operating the INC, OGT, ITNP key if provided, or set the TSTA or TSTB switch to the required position.

(b) Select class of call and type of translation. On some types of master test control frames local translation is prewired and no key need be operated.

(c) Select the particular CM which produced the record card.

(d) Digits A(0-9) through K(0-9) can be operated to simulate the called number registered on the trouble record card.

(e) Operate the class-of-service key(s) or switch(es) as indicated on the trouble record card.

(f) Set up the line location indicated by the trouble record card.

(g) With the FS/NTFS key normal, the CM selects a trunk link frame in the same manner that it would on a service call. By operating the FS key along with the FG(0-2) key and an GS(0-9) key or the FS(0-9) switch, the CM selects a trunk link frame in the normal manner but is restricted to selecting only that trunk link frame corresponding to the operated FS(0-9) keys or switch. The NTFS key is intended for use when it is desirable to select a trunk which is maintenance busy. An operated NTFS key permits selection of a particular trunk link frame (under control of the FG(0-2) and FS(0-9) keys without first testing for idle trunks on that trunk link frame.

(h) With the TS/NTTS key normal, the CM selects a trunk in the normal manner. With the TS key operated (along with the TS0-19) key or the TST1 key with TSU0-9 switch), the CM selects a trunk in the normal manner, but is restricted to selecting only that trunk corresponding to the operated TS0-19, or the setting of the TST1 key and TSU switch. With NTTS key operated, control of trunk selection by the marker is similar to TS key operated. However, in addition, the TST relay in the trunk link frame is operated. When the TST relay operates, all trunks which are made busy on the trunk link frame are restored to service (MB relay releases). It is, therefore, possible to select a particular trunk with TS(0-9) key operated, which is maintenance busy. The maintenance busy condition is removed only during the time that the marker (engaged on the test call) is connected to the trunk link frame.

(i) Operate the tandem trunk number hundreds tens units (HT-TT-UT) keys/switches to control tandem trunk number transmitted to marker on an INC class of test when the Tan key/switch is operated.

(j) Outgoing sender selection, if used, can be selected by operating SGA/SGB key for subgroup A or B, with OSS key operated. The SGA or SGB key operated directs the marker to connect to the A or B subgroup of senders respectively without first testing for an idle sender. The operated OS(0-4) key or switch allows the marker to select only the sender which corresponds to the operated key. The plug-busy condition is removed from all senders of the subgroup after the marker gains access to the subgroup.

(k) A particular path through the network from a line in a particular horizontal group on a line link frame to a trunk on a particular trunk link switch of a trunk link frame is defined by channel number of junctor group.

(1) Operation of a CH(0-9) key or CH(0-9) switch will direct the CM to select that channel number.

(2) Selection of a particular junctor group is not quite as straightforward. Reference should be made to the chart of SFD-D908 to select the horizontal line of the chart corresponding to the size of office. Note that the same junctor group may be selected in two or more junctor sequence positions and is dependent on junctor step position 1 or 2.

(3) The JSQ(0-5) key or switch should be operated to select a junctor sequence position which associates with the junctor group for the junctor step selected. In some cases, the JSQ(0-5) key or switch might be set in any of several positions to select the desired junctor group.

G9-4 USE OF CLASS OF TEST TABLES

The class-of-test tables shown on SFD-G910 through G915 summarize, in tabular form, the key(s) and switch(es) used to establish a particular class of test. A single line is used to separate a particular function with its associated figure, option, key, or switch. The double line within the single lines is used to separate the various options on vintages of master test control frames. The note column and sheet notes are as follows:

(a) Note 1 indicates that all key(s) or switch(es) must be operated to make a proper test frame setup for the particular class of test. It is suggested that known working equipment must be selected for test.

(b) Note 2 indicates the key(s) or switch(es) to be used to simulate the trouble record. Refer to simulation tables in SFD-G902, G904 or G906 and their associated colored trouble record card on the opposite pages G903 G905 or G907 of the simulated table selected. The tables and colored trouble record cards, along with the class of test tables, will assist the maintenance personnel in selecting the proper key(s) or switch(es) to be operated in order to properly simulate the reported trouble condition.

(c) Note 3 indicates those key(s) or switch(es) used for additional marker tests but they are not necessarily required for trouble record test or simulation test.

G9-5 TANDEM CLASS OF MARKER TEST (SFD-G910,G911)

On tandem class of marker test, the master test control circuit simulates an incoming tandem trunk, incoming register and incoming register marker connector.

The marker then functions in accordance with the information with which it is primed to establish a connection from the line location of a simulated tandem incoming trunk to an outgoing trunk arranged for tandem operation. Line hold magnet operation is simulated by the master test control circuit if the NTC key is not operated. If the NTC key is operated, the no-test hold magnet in the associated horizontal group is operated to extend the channel connection back to the master test control frame.

G9-6 INCOMING TANDEM TRUNK TEST (ITNP) CLASS OF TEST (SFD-G912-G913)

The ITNP-TAN class of test is used for testing tandem completion of tandem incoming trunks. The trunk test circuit making an ITNP test closes the tip and ring and grounds the "D" lead of the tandem trunk. The trunk seizes and IR and because of the grounded "D" lead connects to a marker immediately without waiting for a number to be pulsed. The marker receiving a test indication from the register connects through the MTFC to the MTC which supplies the code of an outgoing route. The marker sets up the necessary connection from the line link appearance of the tandem incoming trunk to the OGT arranged for tandem in the normal manner.

G9-7 OGT TRUNK TEST - TANDEM CLASS (SFD-G914,G915)

The OGT class of trunk test is used for testing outgoing trunks which require senders. On a tandem class of OGT trunk test, the master test control circuit connects to the trunk test circuit and signals it to prepare for a test of an outgoing tandem trunk. The test circuit simulates an incoming tandem trunk and an incoming register and proceeds to connect to a marker which it directs to set up a connection from the originating test line for tandem trunks to the tandem outgoing trunk to be tested. The marker is signaled to operate the TT relay in the trunk which gives the trunk test circuit access to the outgoing end of the trunk. An ND signal is given to the sender to allow it to release without pulsing.

After the TT relay in the outgoing trunk circuit has operated, the TT relay connects the outgoing tip and ring, TO and RO, of the trunk circuit into a multiple which is extended to the trunk test circuit.

The SFD-G914 and G915 summarize, in a tabular form, the keys and switches necessary to test an OGT tandem class of call from the master test control frame.